Mariners Weather Log

Summer 1990

Vol. 34, No. 3

Vermilion Lighthouse

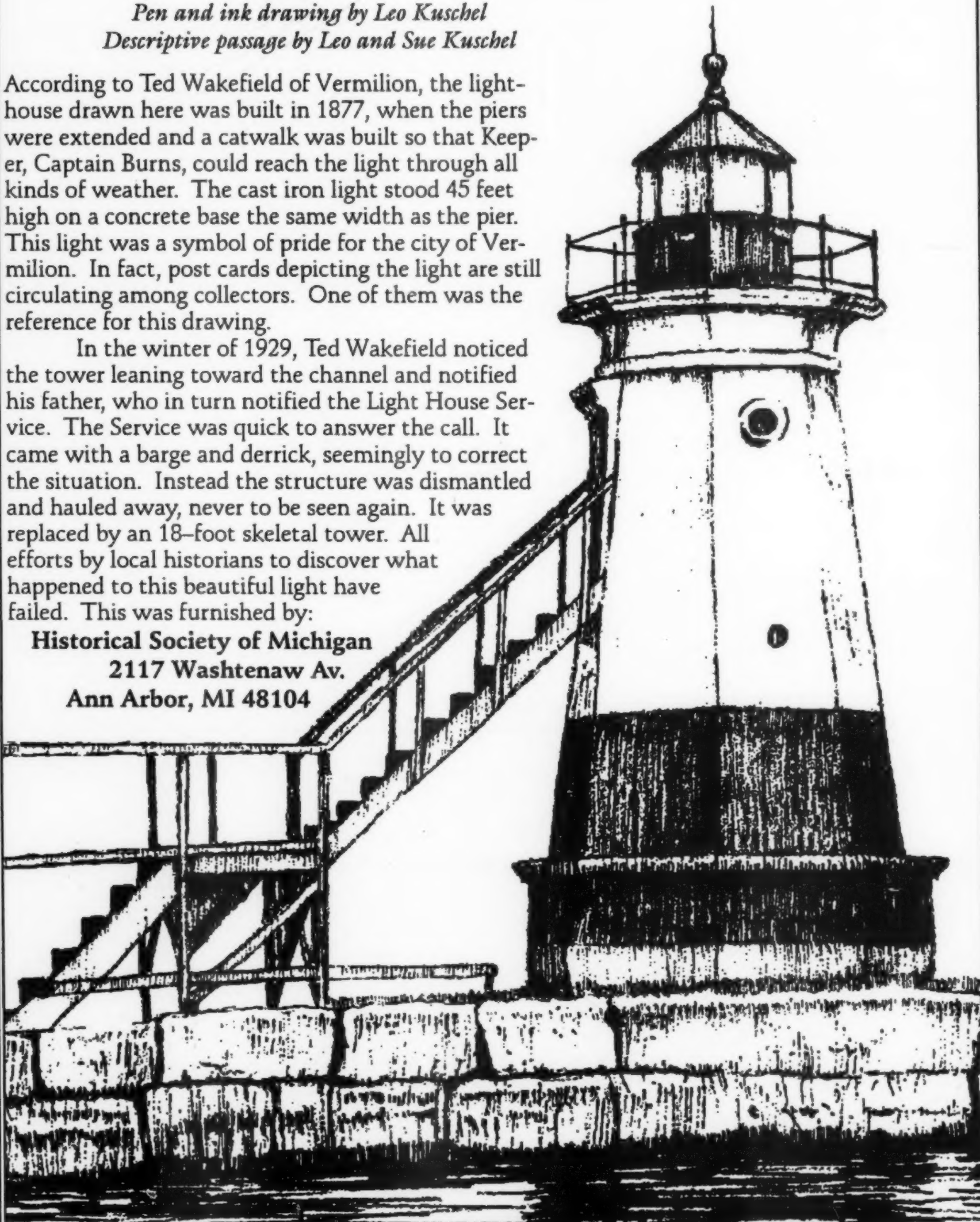
Lake Erie, Ohio

Pen and ink drawing by Leo Kuschel
Descriptive passage by Leo and Sue Kuschel

According to Ted Wakefield of Vermilion, the lighthouse drawn here was built in 1877, when the piers were extended and a catwalk was built so that Keeper, Captain Burns, could reach the light through all kinds of weather. The cast iron light stood 45 feet high on a concrete base the same width as the pier. This light was a symbol of pride for the city of Vermilion. In fact, post cards depicting the light are still circulating among collectors. One of them was the reference for this drawing.

In the winter of 1929, Ted Wakefield noticed the tower leaning toward the channel and notified his father, who in turn notified the Light House Service. The Service was quick to answer the call. It came with a barge and derrick, seemingly to correct the situation. Instead the structure was dismantled and hauled away, never to be seen again. It was replaced by an 18–foot skeletal tower. All efforts by local historians to discover what happened to this beautiful light have failed. This was furnished by:

Historical Society of Michigan
2117 Washtenaw Av.
Ann Arbor, MI 48104

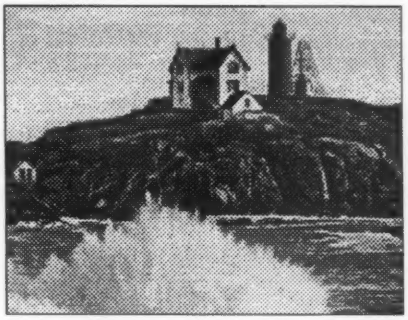


Mariners Weather Log

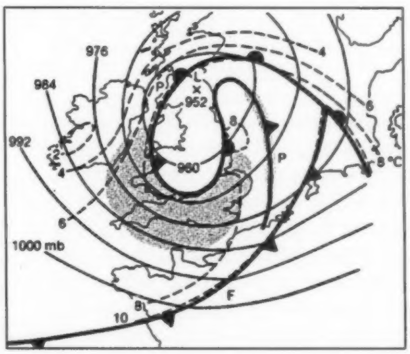
Vol. 34, No. 3

July, August and September 1990

Features



page 20



page 54

Departments

Marine Weather Review

Editor: Richard M. DeAngelis

U.S. Department of Commerce
Robert A. Mosbacher, Secretary

National Oceanic and Atmospheric Administration
Dr. John A. Knauss, Administrator

National Environmental Satellite, Data, and Information Service
Thomas N. Pyke Jr., Assistant Administrator

National Weather Service
Elbert W. Friday Jr., Assistant Administrator

National Oceanographic Data Center
Gregory W. Withee, Director

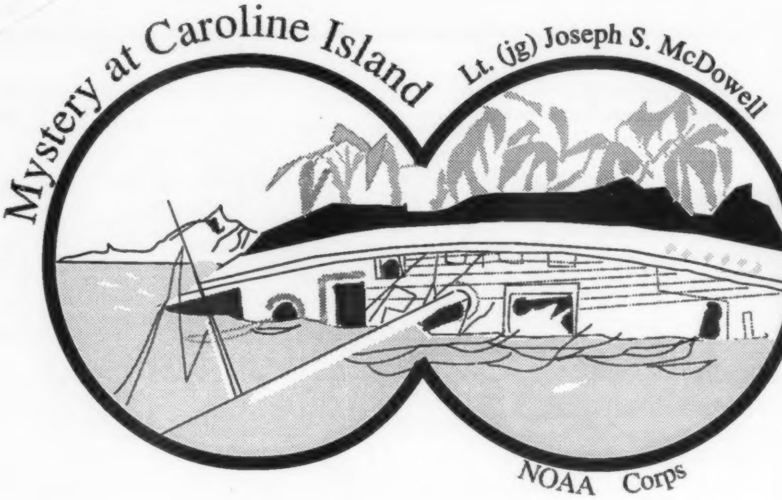
Cover: This well–formed, mature waterspout was photographed by Joseph Golden 14 miles northwest of Key West, FL in September of 1969. Notice the spray sheath at the lower portion of the funnel.

Back Cover: The 200th anniversary celebration of the U.S. Coast Guard continues. The ***Joe Lane*** was known as the *queen of the sailing cutters.* Originally christened ***Campbell***, this big two–masted schooner's name was changed in 1855 to honor a U.S. congressman from Oregon. It had a long and busy career, mostly off the coasts of California and Oregon. The drawings are based upon the research of the famous historian Howard I. Chapelle.

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through July 1, 1991.

The **Mariners Weather Log** (ISSN:0025–3367) is published quarterly by the **National Oceanographic Data Center**, National Environmental Satellite, Data, and Information Service, NOAA, Washington DC 20235 (telephone; 202–673–5561). Funding is provided by the **National Weather Service**, NOAA. Data is provided by the **National Climatic Data Center**, NOAA. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington DC 20402. Articles and photographs (will be returned) should be sent to: Editor, Mariners Weather Log, National Oceanographic Data Center, Washington DC 20235.

*The South Pacific has always been romantic and mysterious. From Mutiny on the Bounty to Paul Gauguin to Marlon Brando, the stories of the South Seas have captured the imagination. Josh McDowell, aboard the NOAA ship **Researcher**, witnessed a mystery at an unihabited atoll in the Line Islands. Part 2 tells — the rest of the story.*



Commander Steve Manzo found the campsite. Broken coconut husks lay on the ground aside empty tins of food in neglected disorder. Some of the tins were unopened. Old clothes and a piece of a sail littered the site. The sail had been used as shelter. There were no signs of survivors. When Manzo looked closer he found parts of a spear and other makeshift tools of survival. Rummaging amongst the flotsam, Steve's eyes fell upon the wrecked ship's log. Maybe now the story would unfold.

It was mid–June 1987 and the NOAA Ship ***Researcher*** was steaming south to Tahiti from Hawaii, conducting oceanographic studies. The scientific personnel aboard covered a broad range of disciplines, which stretched from chemistry to ornithology.

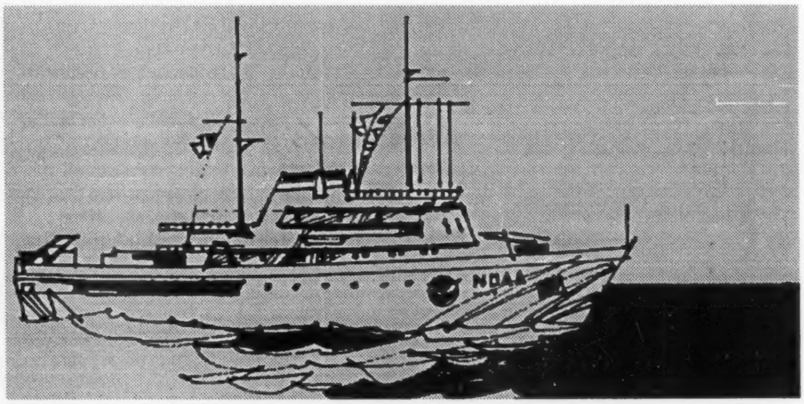
It is because of the bird watchers aboard that I am able to tell this story. One would think that there is not much bird life out at sea except close to land, yet never a day went by that I did not see at least two or three different species of sea birds.

The ship was ahead of schedule so the chief scientist, Dr. Peter Ortner, asked Captain Ted Wyzewski if we could make a minor diversion from our course. He wanted to do a bird population study on a small atoll called Caroline Island, where nothing had been done for 20 years. The captain agreed and permission was received from the State Department, since Caroline Island is a possession of the island nation of Kiribati.

Shipboard atmosphere was filled with excitement. In preparation the ornitholgists studied old papers making careful notes on the types of birds they expected to find. There was no mention of a small dark sea bird called a petrel. Yet that name would soon touch everyone on board.

On the morning of the 16th of June we were due to sight land.

On the morning of the 16th of June we were due to sight land, always a



time of anticipation. This was doubly so because we were to be the first people on this island in 20 years. It was time for the morning watch change and all on bridge watch were being briefed. In one briefing book was a message from the Coast Guard about a sailboat called the ***Albatross***, which, about 2 weeks earlier, was reported lost in our area. With sailors the world over the feeling is the same when we have lost one of our own. Still, the mood on the bridge was charged; we were to explore an island where few people had ever been.

*NOAA's **Researcher** (left and previous page) is an oceanographic research vessel operated by the National Ocean Service. On March 1, 1988 the vessel was renamed the **Malcolm Baldrige** in recognition of the late Secretary of the Department of Commerce. The 278–foot, 2963–ton vessel is the largest of NOAA's East Coast fleet of 23 research and survey ships.*

NOAA

The lookout called into the pilot house: "Land just off the starboard bow."

About 30 minutes into the watch land could be seen on radar. The lookouts were told the island's location relative to our heading, and they scanned the horizon with binoculars, each hoping to be the first to sight land.

One could see far in the early morning air and already the hot, tropical sun was gleaming off the water. Every so often a school of flying fish would glide by, just skimming the swells to escape the white steel hull of the ship. The birds were becoming more numerous as they waited for the silver flying fish to emerge from the waves so they could dart down and catch them. Back and forth the birds would weave across the bow wake, mimicking the rise and fall of the waves as they hunted for an unlucky flying fish to eat.

Joseph McDowell

Searching for the island, the lookout was alternating between using his eyes and his binoculars. He was a bearded man whose weathered neck was carved with the lines of the many years he'd spent in the tropical sun. All at once tops of palms poked over the rim of the horizon. The lookout called into the pilot house: " Land just off the starboard bow!" Each member of the bridge watch picked up their glasses to look. The deck officer phoned to inform the captain.

The captain soon arrived on the bridge to take the ship in close to shore. There were no detailed charts of the island aboard, so we did not have a good idea of the bottom depths. On the day before the chief scientist had talked via radio to the last ornithologist who had been on the island to find out where there was a channel through the reef. Twenty years is a long time and the old birdwatcher was not sure enough in his information to risk the ship. Captain Wyzewski, a well seasoned mariner, employed the same techniques used in the days before depth sounders. Surely and steadily the captain guided the ship closer to shore using the color of the water and the breaking waves on the reefs to aid in his navigation.

About 4 miles offshore the lookout called: "There's a boat on the beach."

Hovering birds as big as gulls were numerous. Some had so little fear they would hover a couple of feet from the people on deck, while others perched on railings. It was time for our daily weather balloon launch. The birds seemed fascinated with this big, red, round bird that had no wings and they followed it as it climbed across the bright tropical sky.

About 4 miles offshore the lookout called: "There's a boat on the beach!" Everyone picked up binoculars to confirm the sighting. The bridge became quiet as we neared shore and the boat came into view. It was similar in color to the ***Albatross***.

Eagerly the watch looked up and down the beach hoping to see signs of life. No smoke rose from camp

Gary Mundell

around the island looking for some opening to pass through the reef. The approach to the reef was treacherous. Breakers would rise and crash so quickly that if the *zodiac* got too close, she would be dashed to bits if she were caught by a wave. The skilled coxswain rode the crests of the swells to look for a safe passage while he had good visibility. In the trough of the swell all he could see were mounds of water.

During this circumnavigation, we aboard the ***Researcher*** radioed the Coast Guard to tell them that we may have found the ***Albatross***.

The rescue boat was now ready for launching. Deck hands tended all lines to steady the aluminum hull as it was lowered over the side. The chief boatswain called out commands to slack this line or heave in on that line. Because of its size, handling the rescue boat was not as easy as launching the *Zodiac*. Timing had to be just right with the roll of the ship and the heave of the swells for the boat to go into the water safely.

The rudder was gone and the ballast had been sheared from the keel.

fires, and no shelters were visible. A grim feeling settled over the entire ship as word passed about the wreck. The boat was on her starboard side and washed all the way up to the storm tide line; it was not hard to tell that she was badly damaged. But the question still remained: "What had happened to the crew ?" The ship's doctor had been informed that he would go ashore with the landing party. Dr. Jim Erickson was a tall man who had an easy way about him and you felt comfortable when he was around. Carefully, he packed a medical kit with essentials in case there were survivors. Grimly, he asked for a body bag in the event that we were too late to save the marooned sailors.

It was midday and the first launch over the side was a small *zodiac*, a rubber raft with an outboard motor. In it were the coxswain and the two ornithologists. All three were in shorts and sat in the boat with their equipment as the crane hoisted them over the railing and down toward the water.

The bridge kept in close radio contact with the little boat as she sped

This fast, maneuverable boat, the favorite of the coxswains, was very stable even in rough seas. Big orange pontoons ran all along the rim of the hull and were ideal to sit on. In the boat were the captain, the chief scientist, the doctor, our operations officer, Commander Steve Manzo, and a few members of the crew.

The zodiac was still searching for a channel. An hour passed and finally the rescue boat found a narrow, shallow channel through the reef. Carefully, she squeezed through to the calm waters behind the breakers and nosed on to the beach. The *zodiac* soon followed.

The doctor was the first to

jump ashore. He proceeded at a slow jog toward the wreck carrying his medical kit and camera. Commander Manzo headed off to find any campsites that the survivors may have pitched. Others searched in different directions.

The next entry was ominously simple: "12 September 1985 Shipwrecked."

As the doctor ran along the beach, black-tipped sharks shadowed his pace. Closer, Dr. Erickson saw that the boat was not the ***Albatross*** after all, but the name ***Petrel*** was painted on the stern. The rudder was gone and the ballast had been sheared from the keel. The boat had been scavenged. There was no boom and many of the fittings were missing. Inside, he saw that the radio and compass had been removed. Sand and old palm fronds were scattered around and old clothes lay helter-skelter through the cabin. Walking outside, the doctor saw the registration sticker, Alaskan registry dated 1985, and copied the serial number on a note pad for the Coast Guard. Obviously no one had been aboard for months. As his shipmates arrived, Dr. Erickson showed them the hole in the hull on the starboard side. One of the group stepped just a little too close to the water and a black-tipped shark surged out of the surf in an attempt to bite his heels. The shore party scattered jumping away from the water's edge. Defeated, the shark pulled back and swam out of sight.

In the shade of the coconut palms of the campsite, Steve Manzo turned the stiff pages of the weathered log. The entry dated September 7th, 1985 said: "... dropped Dee off in Bora Bora." The skipper then wrote that he had set sail alone. The next entry was ominously simple: "12 September 1985 Shipwrecked."

The conclusion reached was that he had put to sea never to be heard from again.

Steve read on. This castaway sailor had been worried about the water supply. He kept his wits, however, and solved the problem by stretching sails across the beach to catch the daily tropical rainfall. An entry made a few days later noted that water was no longer a problem. Irregularly made log entries revealed that the skipper of the *Petrel* was eating mostly shark, turtle and coconuts. The island's numerous bugs bothered him. Another entry said that he had seen no ships. As time passed it was clear that the business of survival had become routine. Later, in a disturbing entry, he thought he had ciguatera, a rare disease of the nervous system caused by eating tropical fish; the survivor thought he was going mad. He wanted to escape from Caroline Island and wrote of building a raft, and drew diagrams of it in the log. He divided one page into two columns and listed reasons to go and reasons to stay. He felt that no one would fish near this island and that his chances of rescue would improve if he left. In the *stay* column he acknowledged that food and water were plentiful on the island. The choice was not easy.

Gary Mundell

The sailboat spotted on the beach (previous page) was the Petrel and not the Albatross. The vessel was sailed by Gary Mundell of Alaska, who shipwrecked on Caroline Island (right). The Albatross is still listed as missing.

The last entry made on the 27th of October read: " The raft is loaded and ready to go. A decision must be made." Yet no raft was found.

Steve returned to the wreck with the log. All agreed that the castaway was not on the island. The conclusion reached was that the he had put to sea never to be heard from again. With a somber spirit the group spent the rest of the day quietly studying island bird life.

On return to the ***Researcher*** we radioed the Coast Guard in Hawaii to tell them that we had found the log but no survivor. The Coast Guard relayed the registration number to a station in Alaska with all the details. At the Alaskan station the duty officer had the unenviable task of calling the next of kin to tell them that after 2 years all that had been found was a derelict boat and its log. When the phone was picked up a male voice answered... it was Mr. Gary Mundell the skipper of the Petrel himself. He had been rescued by a French ship.

News that the castaway was alive was radioed to us just before dinner. We were elated. The messes were filled with conversation about the odyssey of the ***Petrel's*** skipper.

The tropical sun hung just above the horizon as the ***Researcher*** steamed out of sight of Caroline Island. Morale was still high on the bridge as the evening watch received their brief. There on the chart table lay the briefing book. Still clipped to its first page was the message about the lost sailboat ***Albatross.***

Castaway

Gary Mundell
and
Rick Folstad

On September 6, 1985, 35 year–old Gary Mundell of Soldotna, Alaska, set sail from Bora Bora, French Polynesia, bound for Hawaii aboard his Cape Dory 27, **Petrel**. *For nearly two years Gary had roamed the South Pacific, usually with crew, but on this northbound passage of 2,200 miles he was alone. Instead of the usual steady southeast trade winds he found blustery northeasterlies, forcing him to sail hard on the wind and make frequent sail changes. After 5 days at sea,* **Petrel** *had logged less than 350 miles and Gary had slept just one hour in the last 36. His noon sight on September 11 placed him 60 miles south of Caroline Island. By midnight he calculated he should have been well past the low lying island. At 2 a.m. with the steering vane guiding* **Petrel** *north under double reefed main and working jib, the exhausted skipper turned in to his bunk. A mere 2 ½ hours later, in total darkness,* **Petrel** *was driven ashore at Caroline Island and Gary Mundell was castaway on the deserted atoll. This is the story of how he survived. All photographs were taken by Gary Mundell.*

In the dim, predawn hours of September 12, I awoke with a jolt as *Petrel*, my Cape Dory 27 lurched then reeled on her side.

I stumbled to the companionway and was hit flush in the face by a breaking wave as *Petrel* again shuddered and rolled. I put on my harness and scrambled to the cockpit. The sails were aback and *Petrel* was heeled heavily to starboard. Even after casting off the sheets, she didn't come up. My first thought was; What kind of weird current are we in? In the faint light was the outline of palm trees. I stared at those trees for a full second in total disbelief. It could only be the southernmost motu (islet) of Caroline Island, a coral atoll lying at 10°S, 150°W.

I have always considered myself a survivor, always looked at adversity as sort of a personal challenge. I knew I would survive this grounding, but I had to get *Petrel* off before she was crushed on the reef.

Petrel lay heavily on her starboard side with her rail awash. Each wave pushed her 6 or 8 feet closer to shore. My only hope to refloat her was to kedge her back over the reef to deep water, the same way she'd sailed in. I put on my shoes and rigged my heaviest anchor. Easing myself over the starboard side into knee–deep surf, I walked the anchor out to the edge of the reef, planted it, waded back to the boat and tried to winch *Petrel* to deeper water. But the sheet winch and nylon anchor rope could not budge the 7,500–pound boat that now lay in only 18 inches of water.

There seemed no alternative but to wade ashore in the growing daylight to search for help— any kind of help. The reef was as flat as a tabletop and without shoes the coral would have cut my feet apart. Clusters of black spiny sea urchins and several small but aggressive, black–tipped sharks inspired a new plan; I inflated the Avon dinghy and paddled in.

Once ashore, I sat for a few minutes on the coral sand beach and looked at *Petrel* listing at 45°, her starboard deck awash. I felt lucky to be alive.

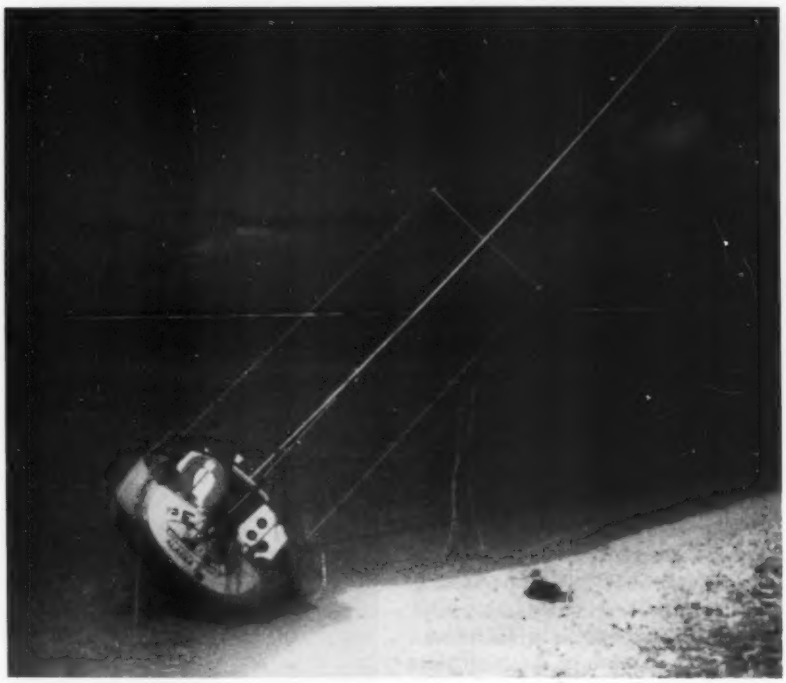
The beach was deserted, although a survey marker, left on the island just 3 months earlier, confirmed that this was Caroline Island. I spent an hour scouring the motu, tramping through thick brush and coconut palms looking for footprints — any sign of human life. Thousands of seabirds wheeled overhead, coconut crabs scurried into the bush and clouds of mosquitoes buzzed my ears, but the only footprints in the sand were my own.

I returned to *Petrel* to assess the damage. The starboard lower shrouds had parted. Though the hull was scratched and gouged, it was intact and had taken the grounding well. But there was simply no way to kedge her off myself. I went below, turned on the VHF radio and broadcast a mayday over the next 45 minutes. There was no response. A check of the chart showed Caroline Island to be a submerged coral atoll 7 miles long, 1mile wide, its rim dotted with 40 motus, which enclosed a shallow lagoon.

With no way of anticipating a rescue, I began to prepare for an indefinite layover and started rowing gear ashore.

On my first trip I ferried the liferaft, 10 gallons of water, sails, line and an emergency grab bag with solar stills. I figured I could go 30 days on that single load alone.

On the second trip I broadcast another mayday call for half an hour, but again heard no response. I took my spare butane stove, most of the canned goods and fishing and diving gear. A



This story appeared in *Cruising World* magazine in September of 1987. It is with their kind permission that we are able to reprint it.

third trip was hampered by the incoming tide, which sent waves breaking over the reef. The surge moved Petrel shoreward at a hard clip, pounding her against the reef, nearly trapping me between the boat and the reef, and causing more damage.

Survival

I decided to set up camp in a coconut grove up from the beach and stretched a sail overhead for shelter. Then I placed my Avon life raft on a sail, yanked the line and watched it inflate. I had a $2,500, 5-foot-long bed. On the beach in front of the campsite I spelled out SOS with flotsam gathered along the beach.

Already I was mentally preparing myself for a future that offered no promises. Over and over again I repeated: "I am a survivor." I gradually began to adapt to life on the island. I slept in my Avon liferaft to keep the coconut crabs from crawling across me at night. Most of my fresh food was waterlogged, so I ate the remaining fresh stores — eggs, potatoes and onions — that were salvaged from *Petrel*, and rationed the canned goods. I made a crude coconut picker from a double gaff hook hose-clamped to a whisker pole so I could gather nuts to eat and drink. I also ate the huge coconut crabs. Running out of water was a concern so I rigged a sail as a rain-catcher and after some heavy rains collected enough to last for weeks.

The days passed slowly. On the second day, bilge water, lapping up the port side of the hull, flooded the radio making mayday calls impossible. I watched the horizon for ships every half hour, but there were none. I took compass bearings from my campsite all around the horizon and could see the sea except for a 90° arc to the north. Because *Petrel* had landed on the southernmost motu of the atoll, I'd found a pretty good campsite right where we'd crashed.

Every two days I recorded my thoughts on a cassette recorder salvaged from the boat. This helped to keep track of the passing days and to keep my spirits up. From those tapes:

September 19, Day 8:

Yesterday, I took the dinghy across the lagoon and explored the north end of the atoll to see what I could find in the way of past human habitation, but I found nothing... The rats are a real problem in camp, but they haven't gotten into the supplies yet...Its probably just a matter of time before I'm, found. Patience, patience, patience. That's the hard part.

September 23, Day 12:

I still remain in good spirits and good health. Still no sign of shipping. I've come across a crazy idea tonight about building a boat and sailing out of here. I've got most everything off the boat that's useful. She's torn up pretty bad and she's lying on her starboard side. She's never going to float again..I'll give it 90 days. After that I'll try to sail to Penrhyn Island, 460 miles to the west, with the dinghy, my rubber liferaft and an old rubber raft I found abandoned on the far side of the island. It's something I don't want to have to do.

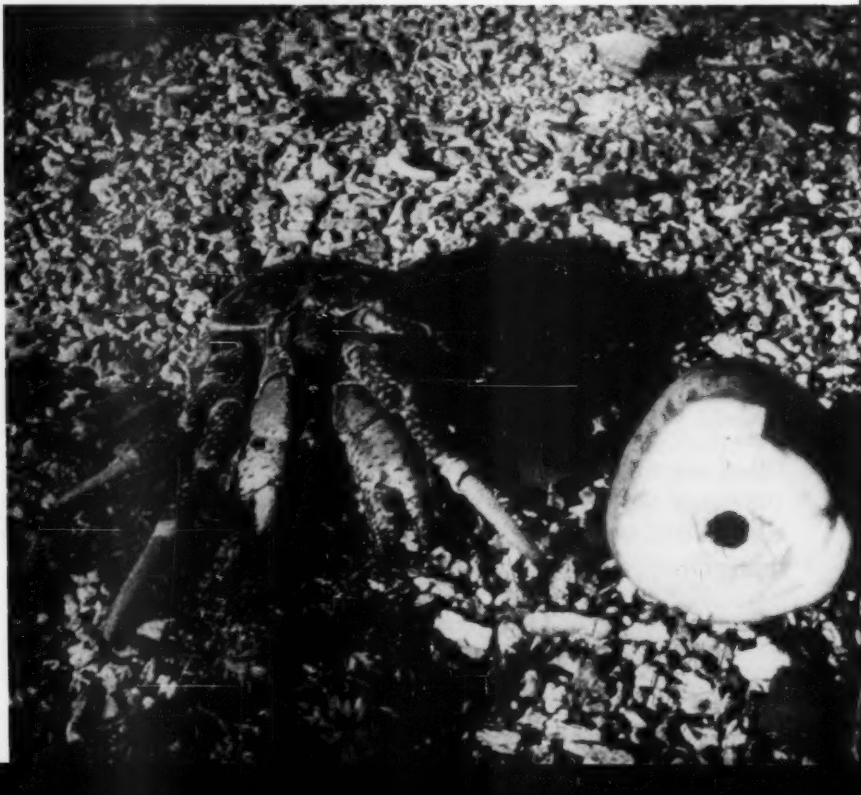
September 25, Day 14:

Two finds while rooting around the boat: a canned ham and a harmonica. I always wanted to learn how to play the harmonica and now's the ideal time. Not a soul around to hear me.

October 10, Day 29:

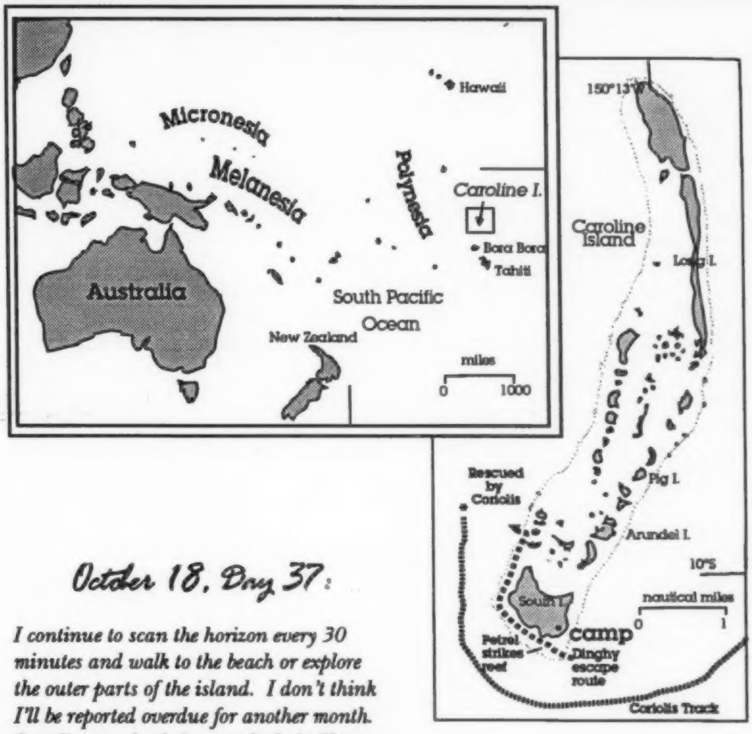
I've strung up an antenna of extension cord for the shortwave radio and believe it or not, Radio Australia is booming in like a top. It's a lot of company. I've dried out a couple of American Hunter magazines, so I have fresh reading material. This morning I speared a small moray eel. I also caught a shark today using fish bait on a hook. I've cut it up, washed it out in salt water to get all the urea out and strung it on a line to dry. My spirits are still up.

My days grew routine. Mornings I would make a cup of instant coffee, watch the sunrise and beachcomb. During the



heat of midday I would rest beneath the sail awning, then walk a new stretch of beach late in the day. At night I would listen to the radio. I heard reports on the bombing of the Greenpeace ship ***Rainbow Warrior*** and thought how insane it all seemed, while here I was alone on this beautiful island.

There was only one time when I really became depressed. The trade winds stopped for about 5 days and the mosquitoes and no–nos came out. It was hot and muggy and miserable. I remembered reading that depression was one symptom of dehydration. I drank great quantities of water and almost immediately my depression disappeared. Then the trades came back, the sun came out and everything was back to normal.



October 13, Day 32:

Thirty days in the hole (singing). Today I fed myself on canned ham, rice with curry sauce and sprouts. I cut my beard and my hair, took a plunge and bathed after the tide came in. It sure feels good...I found a bottle with a note in it written on Ecudorian paper. But the pencil writing has faded and I can't read it.

My month on the island brought about some subtle and some significant changes in the way I perceived my life. I lived moment by moment. I stopped passing judgment. I became unemotional and yet I felt tuned in. I became totally absorbed in the habits of the birds, the nocturnal movements of the crabs and the changes in the beach. I realized the difference between my wants and my needs and resolved to simplify my life considerably after all this was over. I didn't need all the toys to be happy. I was happy just to be alive, I realized that the difference between adventure and an ordeal is attitude, that 90 percent of survival is between the ears.

October 18, Day 37:

I continue to scan the horizon every 30 minutes and walk to the beach or explore the outer parts of the island. I don't think I'll be reported overdue for another month. Supplies are slowly but surely dwindling. I've been quite patient, I think, but I believe I'm eventually going to have to put to sea to get out of here. I don't look forward to that. I designed a square sail rig for the inflatable, which should let me make 30 miles a day. That's at least a 15–day trip to Penrhyn and I think that's feasible. But leaving is an irreversible decision, so, for the time being, I'm going to stay put...With sharks and sea urchins I rarely go in the water for a swim. Instead, I like to take the dinghy out and float over the reef. Manta rays often shadow the boat, staying with me sometimes for 20 to 30 minutes.

October 22, Day 41:

I'm preparing to sail to Penrhyn. I've rigged the mast step and patched the inflatable raft I found. I hate to chop the genoa but it's doing me no good on this island and it may get me out of here. I have an almanac and a sextant so I can get latitude with no problem, I hope. Longitude will be a ballpark operation.

October 27, Day 46:

I've got to leave this island. Got to get to Penrhyn. My goal is to be home for Christmas, so I must leave by the first week of November. I should be overdue now. I have my doubts about the Navy coming all the way down here to look for me, but one never knows, so I'll hang on here another week. I can see myself losing my grip on sanity here if I wait too long, so I want to do something positive.

October 28, Day 47:

I spotted large turtle tracks on the western beach, so last night I returned to the spot. I could hear her digging her nest in the sand. When I saw her in the light of the full moon I didn't want to kill her, but I needed the meat. With a knife and hatchet I tried to do it quickly. She outweighed me two to one

and twice knocked me off my feet, but finally the deed was done.

A Ship!

On October 30, my 49th day on the island, a squall cut short my usual morning walk. I returned to camp, buttoned up my belongings and gathered some rainwater. When the squall passed, I scanned the horizon with my binoculars and contemplated how I would pass Halloween. Unbelievably, to the east, 3 miles away a ship emerged from another squall!

I grabbed my 12-gauge flare gun and fired a German parachute flare. Then another and another, at regular intervals. It was the first time I'd seen a ship in 49 days, and I wasn't taking any chances. I lit off two smoke flares, then some hand-held flares. Then I dumped a jug of kerosene onto a pile of coconut husks and brush I had laid, and lighted it. I signaled to the ship with my signaling mirror. The ship flashed its powerful spotlight at me. I'd been seen!

The French oceanographic vessel *Coriolis* steamed around the south end of the island, apparently looking for a charted small boat pass through the reef, one long since choked with coral. In the manner of a madman, I dumped the rainwater out of my dinghy and frantically began loading it with gear. I pulled on a pair of shorts and put on a red shirt so they could see me. I put my passport, traveler's checks and other valuable papers in a belt pack and strapped it on. Water over the coral was knee-deep and the heavy surf made it tough to approach the edge. I launched the dinghy and paddled until I ran out of water. Then I waded, painter in hand, kicking at sharks as half a dozen charged me. The heavy surf line made it tough to approach the edge of the reef. I turned my back to the swells for just a minute and was hit with a wave that washed me 150 feet back before I could regain my footing. My watch and one shoe were torn off and I was banged up by the coral. I waded back to the edge of the reef again and saw that the *Coriolis* had launched an 18-foot lighter. The lighter crew motioned to me to go farther north and for the next half hour they motored up and down the reef as I waded, looking for the pass, but it just wasn't there.

Then they buoyed a long line and tried to float it to me through the surf line, but it didn't reach me. I realized that I would never be able to bring the dinghy through the 4-foot swells, so I said to hell with it and turned it loose. I ran out between swells and just dived. I swam 100 feet to the lighter and left the island with only the clothes on my back— my lucky welder's cap, shorts, shirt and belt pack.

When I reached the gunwale, a Melanesian crewmember reached over to haul me aboard. But when the boat dipped, I just lunged into the boat and he got out of the way. The captain handed me a liter bottle and said, "Water? Drink?"

"Thank you," I said, grinning from ear to ear. We shook hands all around and they asked me how long I'd been on the island.

Once aboard the *Coriolis*, the captain took me below and asked me what I wanted first.

"A shower!"

While I was showering, he passed in a fresh towel and clean clothes. I dressed and they asked if I wanted something to drink— maybe a beer?

"You bet!"

They handed me a cold Heineken, then took me into the galley where the chef started laying down the chow. The captain came in with a note pad and took down some information on me. Within an hour of my rescue, a telegram was on its way to my folks reporting me safe.

I was given a berth in the captain's quarters and from that time on it was french wine and cheeses, cold beer, gourmet lunches and six-course dinners. Those guys ate like kings. For the next 2 days the *Coriolis* worked the waters around Caroline Island conducting biological surveys. During that time, the crew retrieved most of my possessions by swimming over the reef with my loaded dinghy in tow.

On the third day, November 2, 1985, we steamed due south for Tahti. I left behind my shattered *Petrel*, a costly remnant of my unscheduled layover on an all-but-forgotten atoll.

When it's done holding your ship's garbage, it could hold death for some marine animals.

This plastic trash bag may not look like a jellyfish to you. But to a hungry sea turtle, it might. And when the turtle swallows an empty bag, the mistake becomes fatal.

The problem is more than bags. Plastic six-pack holders sometimes become lodged around the necks and bills of pelicans and other seabirds, ultimately strangling or starving them. Other plastic refuse, either through ingestion or entanglement, causes the deaths of thousands of seals, whales, dolphins and other marine mammals every year.

Plastic debris also causes costly and potentially hazardous delays to shipping when it fouls propellers or clogs intake ports.

It's a critical issue, destined to attract public and government scrutiny if we fail to take action to solve it.

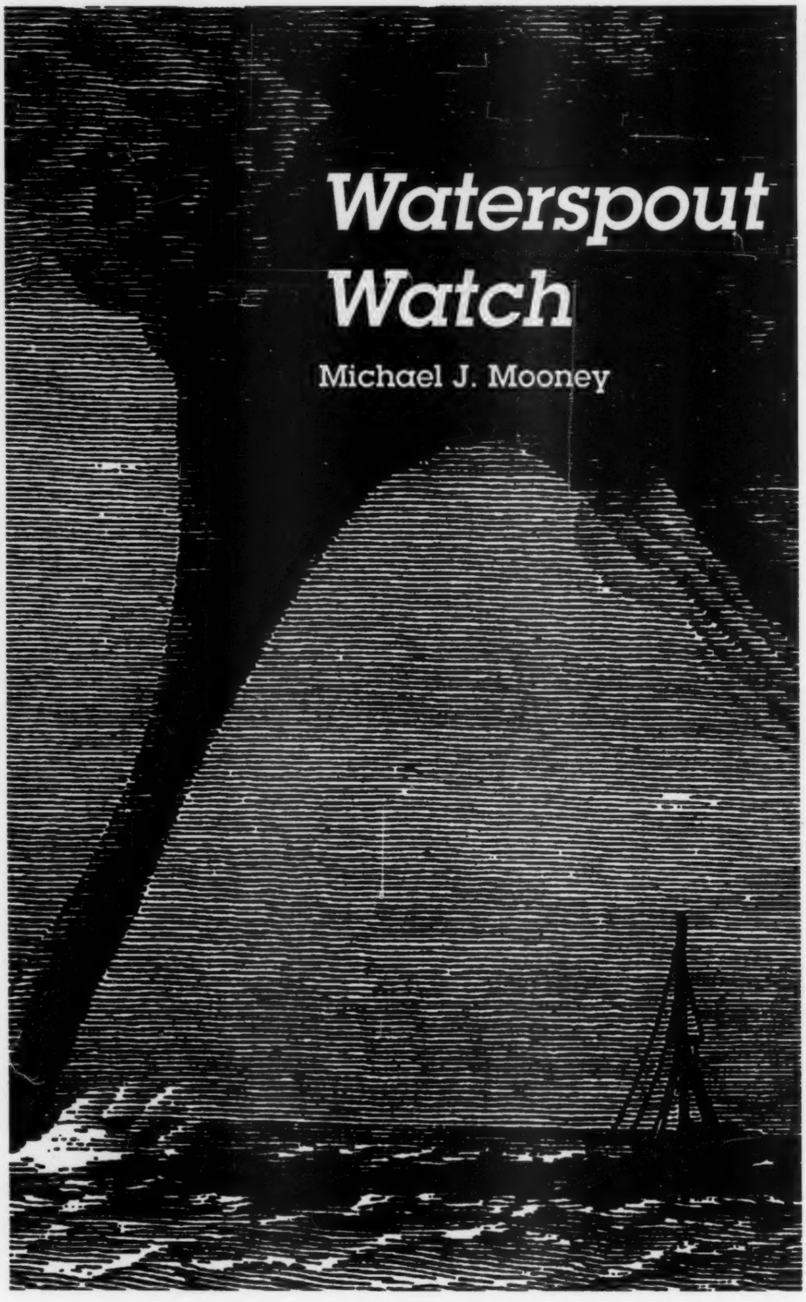
So please, stow your trash, and alert your shipping terminals that you will need proper disposal on land. A sea turtle may not know any better. But now, you do!

To learn more about how you can help, write: Center for Marine Conservation, 1725 De Sales Street, N.W., Suite 500, Washington, D.C. 20036.

A public service message from:
The Center for Marine Conservation
The Natural Oceanic and Atmospheric Administration
The Society of the Plastics Industry

Waterspout Watch

Michael J. Mooney



"... a funnel which contains an intense vortex, sometimes destructive, of small horizontal extent and which occurs over a body of water."
—Dr. Joseph Golden

Picture sailing on a calm sea when silently, mysteriously, a darkened, circular patch of curiously ruffled water appears on the surface. Gradually the disturbance increases and the "dark spot" becomes a revolving ring of sea–spray rising in the shape of a translucent cone. Your attention is drawn to a movement in the heavy, overhanging "parent cloud" above where an incipient, snakelike funnel of cloud matter is writhing down reaching toward the rising cone of seething spray below.

Funnel and cone finally join to form an unbroken "column of water" (or so it seems) extending from cloud–base to sea level. As it sways from side to side in rhythm with the prevailing winds, it looks for all the world like a tornado at sea.

What you have just witnessed was nothing more than the birth of an everyday, run–of–the–mill waterspout.

Waterspouts come in two types; tornadic and fair–weather, depending on how they form.

But what are these weird, funnel–shaped specters that seem to come and go as they please, at various times of day or year, on many oceans or inland bodies of water? Dr. Joseph H. Golden, distinguished authority on vortical storms and now with the NOAA, Chief Scientist's Office in Washington, defines the waterspout as "a funnel which contains an intense vortex, sometimes destructive, of small horizontal extent and which occurs over a body of water."

Waterspouts come in two types: tornadic or fair–weather, depending on how they form.

Tornadic spouts often start over land as true tornadoes and literally go to sea or cross a sizable inland body of water. Often dangerous, they can drop from thunderstorms, squall lines, or the leading edge of an advancing

U.S. Air Force

cold front. They closely resemble the deadly *Texas Twister* complete with sinister, snake–like funnels, enormous parent clouds above, and the frenzied roar of rapidly rotating winds. When fully developed, tornadic spouts are quite large and are capable of considerable destruction.

The second and more common type of waterspout is the fair–weather spout. Unlike its more violent cousin, the fair–weather spout forms only over water, apparently developing at the sea surface and climbing skyward like the old Indian rope trick. Fair–weather spouts are usually small, of short duration, and less dangerous—being more curious than spectacular.

Tornadic waterspouts occur most often in the middle latitudes, usually off the lee shores of large continents...

Prominent meteorologist, Willis E. Hurd once summed up the varied and unpredictable nature of a typical marine waterspout:

"It has been shown that waterspouts spring into their brief existence under all manners and combinations of weather circumstances over warm water and cold water, though most frequently over warm. They are found to occur in weather settled and unsettled; in cyclones and anticyclones; in calms, light winds, and gales; under all sky conditions from cloudless to overcast; in warm weather and in cold; at all seasons of the year. They are found to rotate in either sense, regardless of their low pressure centers; to set their courses directly or at angles with or against the prevailing surface winds; to drop from clouds and rise from the water; to exhibit moderate to terrific forces; to acquire many varieties of shapes and appearances from the ordinary to the grotesque; and to vary in size from small excrescences in the cloud or mere whirls or protuberances on the water, to cloud–and–sea spanning creations of monstrous diameter or length."

Tornadic spouts occur most often in the middle latitudes, usually off the lee shores of large continents like the east coasts of North America, Asia, and Australia where cold continental air sweeps out over warmer ocean water. Fair–weather spouts usually favor the equatorial and subtropical regions. The tropics is home to a broad, variable band of doldrums with its fitful winds and sudden squalls straddling the equator where humid, heated air continually circulates convectionally with cooler air above. In sub–tropic regions, such as the waters off Florida, both types can combine as a hybrid waterspout.

Waterspouts are quasi–seasonal at best and visit the temperate latitudes from spring through fall, while favoring the deep tropics from October through March. On a daily basis, look for waterspouts during the warm midday and afternoon hours. However, nocturnal spouts do occur and can be especially dangerous to the unsuspecting mariner.

How much solid water does a typical marine waterspout contain? Actually very little, since the funnel

Joseph Golden

The antique woodcut on the previous page is from the Hart Archives, New York, NY. The tornadic waterspout (upper left) was spotted in the Adriatic Sea. It is about 2,000 feet high and the funnel is some 200 feet in diameter. The twin waterspouts above were detected west of Marquesas Keys. That is a shower in the background. On the overleaf is a large fully developed fair–weather waterspout with a distinct inner core. This giant waterspout was located about 14 nautical miles north of Key West, FL.

cloud contains condensed fresh water vapor held in suspension by the centrifugal force of its rotating winds. However, surrounding the base of a waterspout is a whirling mass of dense sea spray, called cascade, which can reach heights of 300 to 500 feet or more, rising and falling to the simultaneous pulls of vortex updraft and gravity.

Waterspouts often treat onlookers to exotic sensory multi–displays; the most obvious being visual.

In the northern hemisphere tornadic spouts rotate cyclonically, generating wind speeds up to 200 knots. Meteorologist Hurd told of a vigorous spout whose whirling winds bored clear through the overhanging parent cloud to the blue sky above. On the other hand, fair–weather spouts can and do rotate in either direction, depending on the original convective currents that spawned them and typically have winds of hurricane force or greater.

Fair–weather spouts move along at speeds of 10 to 15 knots while their heavier tornadic cousins churn along at 15 to 30 knots. However, tornadic spouts last about 30 to 60 minutes compared to 2 to 20 minutes for their fair–weather counterparts.

Waterspouts often treat onlookers to exotic sensory multi–displays, the most obvious being visual. Colors from pure white, dirty gray, "blue–black with a tinge of green," to jet black have been reported. Close–up viewers have also heard sighs, hisses, and roars, along with crashes, hums, and grinding noises from the passing leviathans. One even reported a smell like saltpeter.

Tall, slender waterspouts form in dry air where elevated clouds and windshear are prevalent, while short stocky spouts occur with high humidity, lower–lying clouds, and strong convective currents. The longest waterspout on record occurred off Eden, Australia on May 16, 1898, where an eyewitness described it as being "straight as a shaft" and "30 times as high as a clipper ship." It was actually more than 5000 feet high—nearly a full mile above the sea surface.

How dangerous are waterspouts to ocean–going voyagers? Waterspouts have inflicted sporadic but spectacular damage to man and his work over the years. Until the 20th Century, sailing ships bore the brunt of the waterspout's fury. Frank W. Lane, noted authority on natural phenomena, tells of the large tornadic spout that struck Charleston harbor on May 4, 1761 and plowed through an offshore squadron of warships "sinking five and dismasting several more."

A giant spout, fully 500 feet in diameter, sideswiped the barque ***Lillian Morris***, carrying away all masts and sails. One crewman was swept overboard and lost while the captain was whirled about his own poop deck like a harried scrap of paper.

Steamships fared better in bouts with charging waterspouts, due largely to their greater speed and mobility, especially in becalmed weather. Nevertheless, some powered vessels have been struck with surprising damage. On the night of March 30, 1923, a savage nocturnal waterspout struck the

The Life of a Waterspout

According to A.H. Gordon of the British Meteorological Office, the most common fair–weather spouts typically evolve from convective airflow (similar to a land–borne "dust devil") when a high temperature lapse–rate prevails at the sea surface. The patch of air warms and begins to rise causing the surrounding air to swirl in a spiral and form an eddy. This and the presence of considerable water vapor at the surface contribute latent heat of condensation. A steep water–vapor gradient assists in producing the spout since water vapor is lighter than dry air. Cumuluscongestus clouds, with their own convective currents, further promote the formation of a marine waterspout. The original spiralling currents are carried upward until a complete visible funnel is formed.

The great majority of marine waterspouts occur when surrounding barometric pressure stands between 1010 and 1015 millibars, air temperature is 80° to 85° F., and local winds are light and variable. Since the spout itself is an intense low pressure disturbance, barometric pressure can drop well below 1000 millibars within the funnel. One ship's captain reported a instantaneous barometric drop of 21 millibars when a waterspout overtook his ship.

Dr. Joseph H. Golden of NOAA describes waterspout formation as a five–stage process: dark spot, spiral pattern, spray ring, mature vortex (spray vortex), and decay.

(1) The dark spot stage is characterized by a prominent circular light–colored disc on the sea surface surrounded by a dark patch which is diffuse on its outer edges. The dark spot may or may not have an associated funnel cloud at first, but a complete funnel is present from cloud base to sea surface.

(2) The spiral pattern stage is characterized by the development of alternating dark– and light–colored surface bands in spiral pattern around the dark spot.

(3) In the spray ring stage a concentrated spray ring develops around the dark spot with a lengthening funnel above.

(4) During the mature waterspout stage the disturbance attains maximum overall organization and intensity.

(5)Finally, the decay stage sets in where waterspout dissipation is reinforced by cool downdrafts from a nearby developing rain shower.

NOAA

This was part of a family of waterspouts detected in the waters near the Bahamas.

White Star liner ***Pittsburgh*** without warning, wrecking the bridge, severely damaging the chart room, destroying electrical connections, and flooding the officer's quarters. Since even the crow's nest was filled with water, the spout was probably collapsing when the collision occurred, deluging the ship with tons of falling water.

Today, sail and powered vessels alike, especially small craft, sustain the greatest amount of maritime damage. With inshore and offshore waters becoming more heavily frequented by short and long distance navigators, the chances of waterspout encounters are increasing. Dr. Robert H. Simpson, former director of the National Hurricane Center, warns: "Waterspouts are strictly to be avoided. A boat caught in the twisting vortex of a big waterspout could be torn asunder by the sudden explosive pressure change as the swirling vortex passes over ..."

Waterspouts pose a multi–threat to small craft unable to get out of their way. In addition to tornadic rotating winds up to 200 knots, there is: flying debris generated by these winds; sudden pressure reduction posing the threat of enclosed boat cabins exploding; the possible deluge of tons of water; and probable capsizing with the risk of drowning due to wind and waves.




How should the mariner treat a bona fide waterspout encounter? Avoiding a spout is straightforward if you can maneuver freely. First, determine the direction the spout is moving. If it is veering to either side or appears motionless while dwindling in size, relax, there's no danger. The spout is moving away from you.

But if the spout appears motionless or moving to either side while growing in size—look out—it's coming your way! When this happens, steer a course directly away from its projected track at your best speed, especially in the latter stages. Don't try to outrun a waterspout— they're often faster than your best speed. Remember also that spouts can and do change directions suddenly and without warning. If you're becalmed, immobilized, or hemmed in by natural obstacles, again, determine the spout's track. If you feel threatened by a hit or a near miss, batten down all gear securely, furl all sails, and open the ports and hatchways.

Avoiding a spout is straightforward if you can maneuver freely.

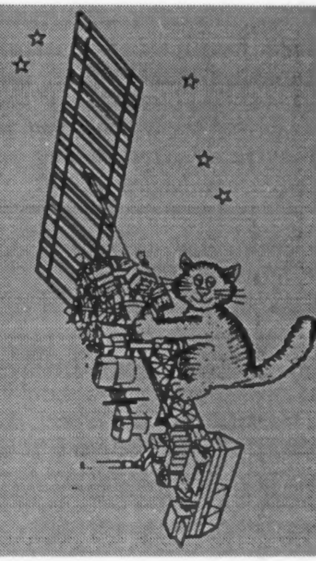
In a small craft, if you seem sure to be *run down* by a spout, have all hands don life jackets and order them over the side away from the approaching waterspout (everyone should know where the spout is at all times). Never try to steer your boat through a waterspout, even a decaying one, which can still be dangerous. At all times maintain the lowest possible profile.

The waterspout's totally unpredictable nature promises no swift solutions to these problems, so it's essential that you keep a mariner's weather eye for suspicious, protruding cloud–bases and curiously disturbed patches of open water. They can be the very birth of a marine waterspout.

Willis B. Hurd again sums up the waterspout's fascinating and unique mystique—typical of the sea itself: "All in all, the waterspout...is most singular, erratic, curiously behaved, and at times dangerous and awesome ..."

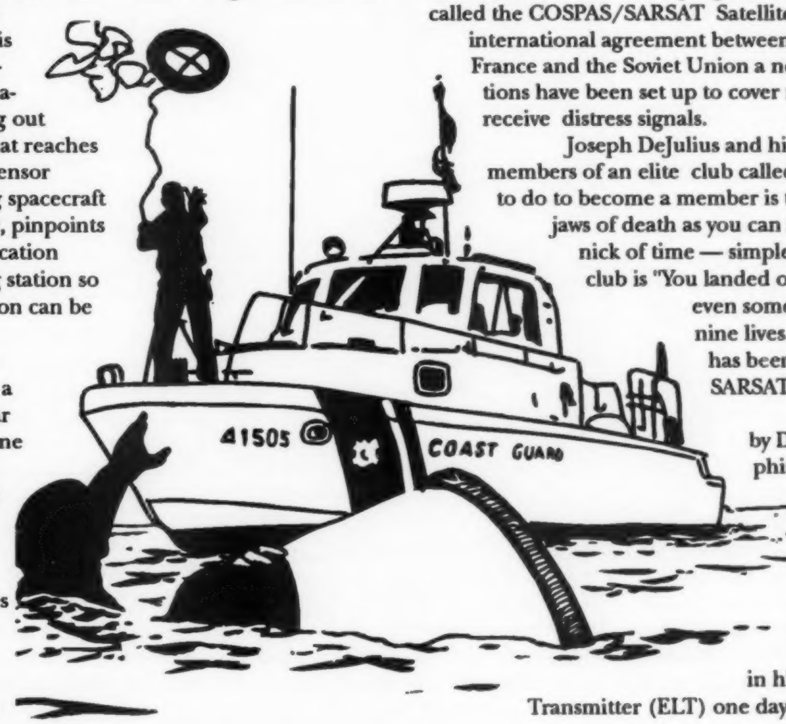
All it takes is a one– on–one encounter with a rogue spout to deep–six your boat—and possibly yourself as well!

SATCATS



Lt. (jg) Joseph S. McDowell
NOAA Corps

A storm at sea is raging at near hurricane force with the waves piled into mountains of water. The decks of a small vessel are awash and she is sinking quickly. The crew begins to jump one by one into the liferaft. The skipper takes with him, into the raft, a small round orange radio that he hopes will save the lives of him and his crew. After activating it, the radio beacon begins sending out a distress signal that reaches out into space. A sensor aboard an orbiting spacecraft picks up the signal, pinpoints it and relays the location back to a receiving station so that a rescue mission can be launched.



Is this the opening scene for a new episode of Star Trek? No, this scene and others like it has been repeated over a thousand times since 1982. The spacecraft is the TIROS-N series weather satellite operated by the National Oceanic and Atmospheric Administration (NOAA). The small orange radio is an Emergency Position Indicator Radio Beacon or EPIRB.

"I would not be alive today if it had not been for the SARSAT system" claims Joe DeJulius. He and his wife were adrift for four days after their trimaran sailboat capsized off the coast of Mexico. The program that saved their lives is called the COSPAS/SARSAT Satellite System. Through an international agreement between the U.S., Canada, France and the Soviet Union a network of ground stations have been set up to cover most of the planet to receive distress signals.

Joseph DeJulius and his wife Jan are both members of an elite club called Satcats. All you have to do to become a member is to come as close to the jaws of death as you can and be rescued in the nick of time — simple. The motto of the club is "You landed on your feet." There are even some who seem to have nine lives. One pilot in Alaska has been rescued twice by the SARSAT system.

Satcats is headed up by Dr. Jeff Justice of Memphis Tennessee. He and his wife were rescued by the system in June of 1986, when his plane crash landed on the Greenland ice cap. Dr. Justice had just changed the batteries in his Emergency Locator Transmitter (ELT) one day earlier. The signal was

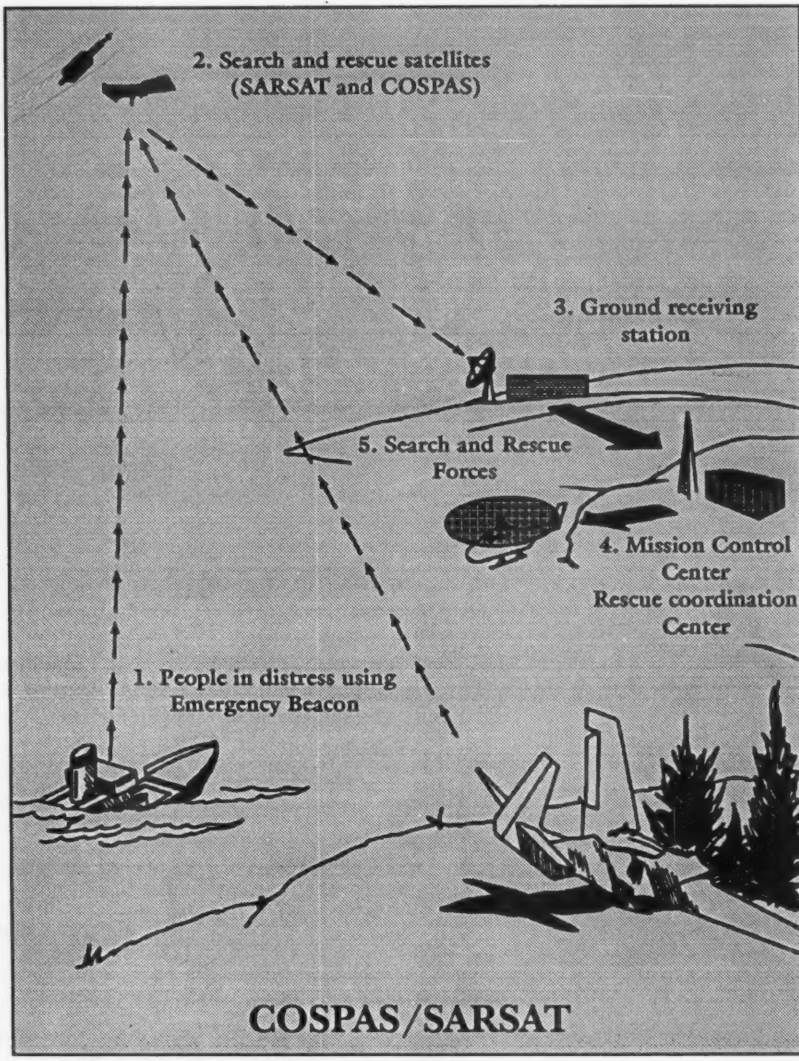
picked up almost immediately and within 6 hours he and his wife were rescued by a Danish helicopter. The rescue took place hours before poor weather closed in on the crash site that could have prevented anyone from getting to them for days.

"We've rescued race car drivers in Africa and dog sled drivers in Alaska,"...

The COSPAS/SARSAT system has a proud record. Success is due to a worldwide system of ground stations that cover every continent except Antarctica. When a satellite picks up a signal, it transmits it to a ground receiving station. The location of the signal is relayed to the U.S. Mission Control Center in Washington, D.C. The nearest Rescue Coordination Center is notified from there and a mission is launched.

"I'll give you an idea of how successful the program is," says Lt. Jeff Salmore of the NOAA Corps and Technical Officer of the program. He reaches into a file cabinet and pulls out a folder as thick as a phone book on the case histories of the successful rescues. Patting his hand on the thick stack he adds: "We have rescued over 1500 people worldwide since the beginning of the program in 1982."

The record includes all types of rescue situations. "We've rescued race car drivers in Africa and dog sled drivers in Alaska," Lt. Salmore says with a broad smile.



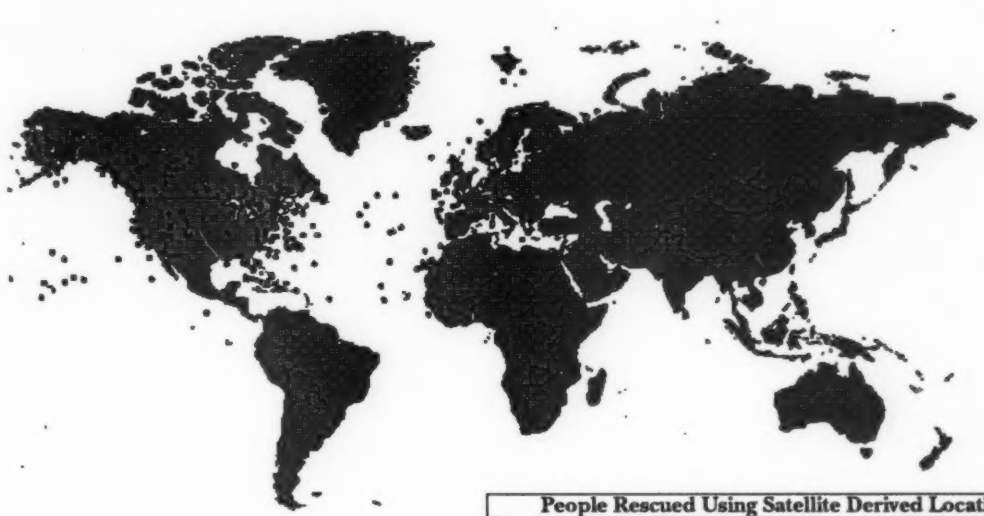
The race car driver was the first to be rescued with the 406 MHz global system. He and his co-driver were on a four continent race from Cape Town, South Africa to Tierra del Fuego, Chile. Early in the race, while driving through a remote part of Somalia, the car rolled over several times. Thrown from the car, the driver suffered a skull fracture. With no phone or medical assistance nearby, the co-driver had no choice but to activate the 406 MHz transmitter. No one had ever used the 406 MHz transmitter before, but the system worked perfectly. SARSAT picked up the signal and dumped it to a receiving station in the United States. After French authorities were notified by the Mission Control Center, a doctor was flown to the crash site. The driver was later evacuated to a hospital where he recovered fast enough to rejoin the race.

As successful as the system is, there is room for improvement. One major improvement can be made by individuals. Over 90% of the signals received are false alarms, all because people don't check their ELT's or EPIB's on a regular schedule. Design improvements are coping with accidental transmission, but the older models that are still out there need regular maintenance to prevent false alarms.

The latest models transmit on 406 MHz, which can pinpoint a distress signal...

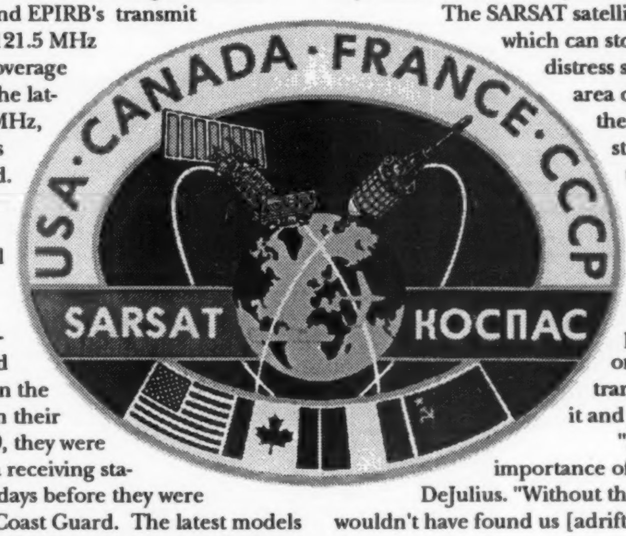
Though most of the globe is covered, there are still some holes in some areas of the world. These limitations in coverage of the receiving sta-

COSPAS/SARSAT Saves and Assists



People Rescued Using Satellite Derived Locations				
	121.5/243 MHz System		406 MHz System	
	Worldwide	U.S.	Worldwide	U.S.
Aviation	743	352	0	0
Maritime	586	223	21	0
Terrestrial	37	12	20	0
Total	1366	587	41	0

tions allows some of the real distress calls to go unheard. The older models of ELT's and EPIRB's transmit a signal with a frequency of 121.5 MHz which has to be within the coverage area of a receiving station. The latest models transmit on 406MHz, which can pinpoint a distress signal any where in the world. The SARSAT satellites have an onboard memory, which can store the 406 MHz signal and relay the location to a receiving station.



One couple in a sailboat off Central America had an EPIRB that transmitted on the 121.5 MHz frequency . When their sailboat sank in June of 1989, they were out of the coverage area of a receiving station and drifted for over 60 days before they were rescued by the Costa Rican Coast Guard. The latest models on the market transmit on 406 MHz, which can be detected anywhere in the world by an orbiting SARSAT spacecraft.

The SARSAT satellites have an onboard memory which can store and pinpoint a 406 MHz distress signal outside the coverage area of a receiving station. When the satellite passes over a ground station it then relays the location of the call for help so that appropriate action can be taken.

The common thread in all the success stories is that all the victims were prepared for the worst. Ask any one of them if the cost of the transmitters or beacons is worth it and you will hear an emphatic yes.

"I can't emphasize enough the importance of being prepared." says Jan DeJulius. "Without the EPIRB the Coast Guard wouldn't have found us [adrift on our trimaran]."

The Nubble Lighthouse

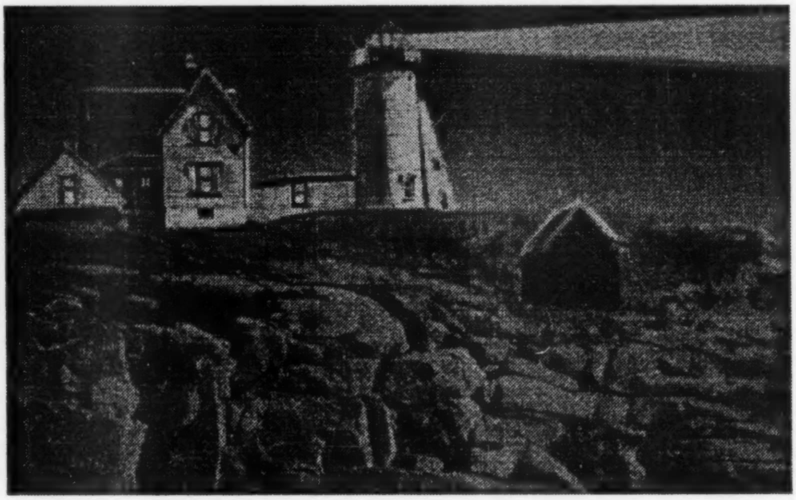
Elinor DeWire
Mystic Seaport Museum
Mystic, CT 06355

In May 1602, English explorer Bartholomew Gosnold sailed down along the Maine Coast near present day Cape Neddick. His journal tells of a friendly encounter with the Abenaki Indians on a pleasant offshore islet they called Savage Rock. The islet was small—only a few acres—and capped by a lush carpet of green grass with wildflowers and gray boulders strewn about. The Abenaki drew a map of the Maine Coast for Gosnold and included Savage Rock on it. If Gosnold was puzzled by the islet's seemingly inappropriate name, those who followed him years later would not be. A century after Gosnold's peaceful meeting with the Indians, Savage Rock would live up to its name when the Abenaki, disgruntled with the English, slaughtered the settlers at Cape Neddick.

Today the pretty little islet wears a more pleasant title and a better reputation. Local residents affectionately call it The Nubble. In summer, when Cape Neddick is teeming with vacationers, shutterbugs congregate on the point across from The Nubble to picnic and photograph its picturesque little lighthouse. Officially called Cape Neddick Light Station, The Nubble Lighthouse has appeared on countless postcards, calendars, and jigsaw puzzles, and in TV and magazine ads. It's one of the most photographed lighthouses in the nation, according to the Maine Publicity Bureau.

Surprisingly, Nubble Light is one of the youngest Maine lighthouses, established in 1878. Requests for a navigational aid at this spot began much earlier though, spurred mainly by the successful Down East fishing industry of the early 19th century.

In 1837, a government lighthouse inspector pointed out the need for a beacon at Cape Neddick, but his



Coast Guard

The picture postcard of Nubble Light (left) was sent in 1943 and is a view from York Beach, ME. The aerial view above shows The Nubble and lighthouse with the Hellespont at near low tide.

suggestion was ignored until 1842 when the bark ***Isadore***, out of Kennebunkport and on her maiden voyage, tragically piled up on Bald Head Cliffs north of The Nubble. One survivor insisted the bark's demise had been revealed to him in a dream the night before; he also pointed out that a beacon in the vicinity of the wreck would have avoided the tragedy.

Not until after the Civil War was work on the tower actually begun.

Public outcry was enormous. A hasty appropriation of money was made for a lighthouse on The Nubble, but the amount was too small, and internal problems within the Lighthouse Service prevented its increase. Not until after the Civil War was work on the tower actually begun.

Cape Neddick Light Station was completed in 1879— a conical iron tower standing 41 feet tall and exhibiting a fixed red beacon from 88 feet above water. The original illuminating apparatus was an incandescent oil vapor lamp that diligently served until electrification in 1938.

The tower was painted in various experimental colors during its early career but has shown a spanking

white daymark since about the turn of the century. A narrow catwalk encircles the lantern, with each of its iron railing posts capped by a charming, miniature lighthouse. The outbuildings are bright red against the Nubble's green crinoline lawn and gray rock trim. The Coast Guard decided to paint the buildings white a few years back, but local residents objected so strongly the red was restored.

Between the mainland and The Nubble is a little channel nicknamed the Hellespont. At low tide, it's sometimes possible to wade across to the islet, but not recommended. A lightkeeper's wife once called a repairman to fix her sewing machine. To her surprise, he knocked at her door with pantlegs rolled up above his knees and his shoes in his toolbox!

Some of lighthouse history's most famous felines have lived at The Nubble...

From the beginning of the lighthouse's career, rats have been the bane of lightkeepers. After Cape Neddick became a popular tourist destination, the rats took up summer residence on the mainland rocks across from the lighthouse, where they could forage in the garbage left by picnickers. In winter, when the tourists were gone, the rats swam out to The Nubble and raided the lighthouse stores.

Traps and poison were a partial remedy, but a more effective and pleasant solution was discovered— cats. Some of lighthouse history's most famous felines have lived at The Nubble—one so popular he appeared in newspapers and was briefly profiled in the annual Lighthouse Service Bulletin.

Keeper Eugene Coleman owned the 19–pound tomcat. Named Sambo Tonkus, he amused tourists and townspeople alike with his insatiable appetite for rats. Sambo was born at the lighthouse and was a gift to Coleman from the keeper preceding him. The cat was content to remain on The Nubble most of the time. But when the rat population on the islet dwindled, or Sambo wanted to carouse in town, he went ashore.

Sambo was captured by many a camera as he ambled down to the Hellespont, dove in and swam ashore, his big paws cutting the waves like paddles. Often, he'd return with a fat rat clenched in his big jaws.

Another problem the Nubble's lightkeepers faced was getting their children to the mainland for school. Most youngsters rowed across the Hellespont in the station dory or lived ashore with relatives during the school year. In 1967, Keeper David Winchester came up with an alternative that made front–page news.

John Terry

Red –Dog (above) companion of Nubble lightstation keepers during the mid 80's surveys his domain from the lighthouse gallery, 46 feet above the ground.

Tuffy of Cape Neddick Light (below) was one of a long line of cats to patrol The Nubble. With the lack of rats his favorite pastime was catching bugs attracted to the tower's powerful beam. Another picture postcard, 1906 vintage, can be seen at right.

John Terry

He rigged a cable from the boathouse to the mainland and attached a small, wooden box to it. Each morning, he placed his son Rickie in the box and hauled him across to the schoolbus waiting on the mainland. Rickie's method of conveyance caught the attention of the media, and reporters flocked to Cape Neddick to see the devoted schoolboy.

When a picture of Rickie, suspended precariously over the Hellespont, was released by the Associated Press, along with a caption extolling his determination to get to school each day, the Coast Guard halted the practice, deeming it too dangerous. But Keeper Winchester and his son were already celebrities. Letters arrived from near and far, offering to help Rickie get to school. Trips in the station boat resumed, however. Rickie's predicament had brought to light one of the many tribulations of growing up on an island.

The Nubble Lighthouse has received many honors over the years, but the highlight of its career came in the 1970s, when a photograph of it was chosen for inclusion in the time capsule aboard the ***Voyager 1*** space probe. The craft explored the outer planets Jupiter and Saturn, then was set adrift. It's time capsule will serve as a greeting to any extraterrestrials finding it.

The Nubble's peaceful image has welcomed, warned, inspired, and soothed for over a century. Now it also floats somewhere beyond the solar system—a lighthouse in the heavens and a beacon of greeting to the rest of the universe from earthlings. The Nubble Lighthouse was automated in 1989, and now stands its watch alone. As with many unattended sentinels, the public would like to see it cared for by docent keepers and opened to visitors.

Radio Broadcast Updates

Jim Nelson
Port Meteorological Officer
National Weather Service

HONOLULU, HAWAII, U.S.A.

CALL SIGN	FREQUENCIES	TIMES	EMISSION	POWER
KVM70	9982.5 kHz	2335-0112	F3C	10 KW
	11090 kHz	0540-0658	F3C	10 KW
	16135 kHz	1105-1242	F3C	10 KW
	23331.5 kHz	1755-1929	F3C	10 KW

TRANS TIME	CONTENTS OF TRANSMISSION	RPM/IOC	VALID TIME	MAP AREA
0001/1201	FULL DISK INFRA-RED SATELLITE IMAGERY	120/576	00/12	GOES
0017/1217	PACIFIC SURFACE ANAL	120/576	18/06	B
0041/1241	TROPICAL SURFACE ANAL	120/576	18/06	C
0107/1307	48HR SURFACE/THICKNESS PROGS	120/576	12/00	D
0127/——	24HR WIND/STREAM PROG	120/576	12/—	E
0152/——	48HR WIND/STREAM PROG	120/576	12/—	E
——/1357	48HR OCEAN WINDS/SIG WAVE HT PROGS	120/576	—/00	F
0533/1733	TEST CHART/ID/SCHEDULE	120/576		
0547/1747	SIGNIFICANT CLOUD FEATURES	120/576	00/12	A
0601/1801	FULL DISK INFRA-RED SATELLITE IMAGERY	120/576	06/18	GOES
0617/1817	PACIFIC SURFACE ANAL	120/576	00/12	B
0641/1841	TROPICAL SURFACE ANAL	120/576	00/12	C
0707/1907	72HR SURFACE/THICKNESS PROGS	120/576	12/00	D
——/1927	72HR OCEAN WINDS/SIG WAVE HT PROGS	120/576	—/12	F
——/1942	OCEAN SURFACE TEMPS	120/576		G
1133/2333	TEST CHART/ID/SCHEDULE	120/576		
1147/2347	SIGNIFICANT CLOUD FEATURES	120/576	06/18	A

MAP AREAS:
A - 40N 160E, 40N 110W, 25S 160E, 25S 110W
B - 55N 130E, 55N 110W, 25S 130E, 25S 110W
C - 30N 120E, 30N 110W, 50S 120E, 50S 110W
D - 60N 110E, 60N 055W, 55S 110E, 55S 055W
E - 50N 120E, 50N 105W, 30S 120E, 30S 105W
F - 60N 130E, 60N 115W, 35S 130E, 35S 115W

G - 60N 100E, 60N 060W, 40S 100E, 40S 060W
ALL CHARTS ARE MERCATOR PROJECTION EXCEPT DISK VIEW FROM THE GEOSTATIONARY SATELLITE FROM ABOVE THE EQUATOR.

NOTES: (1) TROPICAL SURFACE ANAL & WIND/STREAM PROG CHARTS DISPLAY 1000MB STREAM FUNCTION LINES. WIND SPEEDS IN KNOTS FOR ALL LATITUDES MAY BE APPROXIMATED BY DIVIDING 50 BY THE SPACING BETWEEN THE STREAM FUNCTION LINES EXPRESSED IN DEGREES OF LATITUDE. THESE CHARTS, COMPUTER GENERATED AT THE NATIONAL METEOROLOGICAL CENTER (NMC), WASHINGTON, DC, ARE PARTICULARLY USEFUL IN THE TROPICS, WHERE ISOBARIC SPACING AND WIND SPEED RELATIONSHIP BECOMES LESS MEANINGFUL. CENTERS ARE LABELED "A" FOR ANTICYCLONIC CIRCULATION AND "C" FOR CYCLONIC CIRCULATION AND MAY BE EQUATED TO HIGH AND LOW PRESSURE CENTERS, RESPECTIVELY. CAUTION IS ADVISED WHEN USING THESE CHARTS. BEING STRICTLY COMPUTER GENERATED, THEY MAY NOT PROPERLY DELINEATE SMALL, THOUGH INTENSE, SYSTEMS IN DATA-SPARSE AREAS. TO COMPENSATE, NOTES ARE MANUALLY ADDED TO DIRECT ATTENTION TO SUCH SYSTEMS, WHEN PRESENT.

(2) ARROWS ON THE TROPICAL SURFACE ANAL DEPICT VELOCITIES IN KNOTS OF LOWER CLOUDS.

(3) PACIFIC SURFACE ANAL MANUALLY ANALYZED AT THE WEATHER SERVICE FORECAST OFFICE IN HONOLULU DEPICT THE PRESSURE FIELD NORTH OF 15 NORTH AND STREAM LINES (NOT STREAM FUNCTION LINES) SOUTH OF 15 NORTH. STREAM LINES DELINEATE GENERAL DIRECTION OF WIND FLOW.

(4) THE SIGNIFICANT CLOUD FEATURES CHARTS ARE MANUALLY PRODUCED AT WSFO HONOLULU. THEY DEPICT BROAD FEATURES OF CLOUDS BASED UPON IMAGES FROM THE VARIOUS GEOSTATIONARY AND POLAR ORBITING SATELLITES. ABBREVIATIONS USED ON THESE CHARTS INCLUDE: AC -ALTOCUMULUS; AS -ALTOSTRATUS; BKN - BROKEN; CB - CUMULONIMBUS; CC - CIRROCUMULUS CI - CIRRUS; CS - CIRROSTRATUS; CU - CUMULUS; FEW - FEW; ISOL - ISOLATED; LYRS –LAYERS; NS - NIMBOSTRATUS; OVC - OVERCAST; SC - STRATOCUMULUS; SCT - SCATTERED; TCU - TOWERING CUMULUS; TSTM - THUNDERSTORM.

(5) THE SATELLITE IMAGES ARE INFRARED CLOUD PICTURES TRANSMITTED IN REAL TIME AS THEY ARE BEING SCANNED BY GEOSTATIONARY SATELLITE.

(6) OTHER HIGH SEAS MARINE WEATHER BROADCASTS FROM HAWAII:
USCG RADIO NMO HONOLULU - SSB VOICE AT 0545, 1145, 1745 AND 2345 ON 2670 kHz, 6506.4 kHz, 8765.4 kHz, 13113.2 kHz
WWVH KAUAI, HAWAII - AM VOICE ON THE 48TH, 49TH, 50TH, 51st MINUTE OF EACH HOUR ON FREQUENCIES 2.5, 5.0, 10.0, 15.0 mHz.

(7) THE RADIO FREQUENCIES FOR FACSIMILE ARE ASSIGNED FREQUENCIES. TO CONVERT TO CARRIER FREQUENCIES, SUBTRACT 1.9 kHz FROM THE ASSIGNED FREQUENCIES.

(8) YOU MAY ADDRESS COMMENTS ABOUT THIS BROADCAST TO:

REGIONAL DIRECTOR
NATIONAL WEATHER SERVICE, NOAA
P.O. BOX 50027
HONOLULU, HAWAII 96850
PHONE: 808-836-1831

(INFORMATION DATED 01/1990)

VALPARAISO, CHILE

CALL SIGN	FREQUENCIES	TIMES	EMISSION	POWER
CBV	4228 kHz	CONTINUOUS	F3C	1 KW
	8677 kHz	CONTINUOUS	F3C	1 KW
	17146.4 kHz	CONTINUOUS	F3C	1 KW

TRANS TIME	CONTENTS OF TRANSMISSION	RPM/IOC	VALID TIME	MAP AREA
1130	SCHEDULE AND SURFACE ANAL	120/576	0600	
1920	NEPHANAL	120/576	1200	
1940	SEA STATE ANAL	120/576	1200	
2310	SURFACE ANAL	120/576	1800	
2330	SURFACE PROG	120/576		

MAP AREA: 10S 120W, 10S 50W, 80S 130W 80S 30W

(INFORMATION DATED 06/1987)

DARWIN, AUSTRALIA

CALL SIGN	FREQUENCIES	TIMES	EMISSION	POWER
AXI32	5755 kHz	2300-1100	F3C	5 KW
AXI33	7535 kHz	2300-1100	F3C	5 KW
AXI34	10555 kHz	CONTINUOUS	F3C	5 KW
AXI35	15615 kHz	1100-2300	F3C	5 KW
AXI37	18060 kHz	1100-2300	F3C	5 KW

TRANS TIME	CONTENTS OF TRANSMISSION	RPM/IOC	VALID TIME	MAP AREA
0000/——	RECOMMENDED FREQUENCIES FOR AXI RECEPTION	120/576		
0030/——	FAX SCHEDULE	120/576		
0200/1400	CURRENT WARNINGS SUMMARY IN PLAIN LANGUAGE	120/576		H
0215/1430	SURFACE ANAL	120/576	00/12	AUST
0330/1530	ASIAN SIGNIFICANT WX PROG	120/576	18/06	D
0415/——	24HR SURFACE PROG	120/576	00/—	AUST
0605/1745	GRADIENT LEVEL WIND ANAL	120/576	00/12	E
0700/——	MEAN SEA LEVEL PRESSURE ANAL	120/576	0000	A+B
0800/1955	500MB STREAMLINE ANAL	120/576	00/12	C
0820/——	CURRENT WARNINGS SUMMARY IN PLAIN LANGUAGE	120/576		H
0830/2030	24HR 250MB HT WIND/TEMP PROG	120/576	00/12	ASIA
——/2045	CURRENT WARNINGS SUMMARY IN PLAIN LANGUAGE	120/576		H
0905/2100	250MB STREAMLINE ANAL	120/576	00/12	C
0930/2130	18HR SIGNIFICANT WX PROG	120/576	00/12	ASIA
1000/2200	36HR 250MB WIND/TEMP PROG	120/576	06/18	ASIA
1045/2220	700MB STREAMLINE ANAL	120/576	00/12	C
1115/——	SEA SURFACE TEMP ANAL (TUE ONLY)	120/576		E

NOTES: 1. AT THE TIME THIS SCHEDULE WAS ISSUED, THE ASIAN SIG WX ANAL & PROGS ARE ACTUALLY DARWIN AFC SIG WX PROGS. THEY WILL BE REPLACED AT A FUTURE DATE BY THE ASIAN SIG WX PROGS, BUT POSSIBLY WITH MINIMAL NOTICE.

2. NORMAL RECEPTION AREA IS 25N-25S, 75E-180.

MAP AREAS:
A - 35N-35S, 130E-180
B - 30N-35S, 075E-130E
C - 35N-35S, 075E-180
D - 43S 110E, 36S 155E, 36N 142E, 29N 096E
E - 23N-23S, 100E-170E
H - 25N-25S, 080E-180
AUST - 10S 090E, 50S 080E, 10S 170E 50S 180
ASIA - 45N-50S, 100E-180

(INFORMATION DATED 09/1988)

OFFENBACH (MAIN)-HAMBURG/PINNEBERG, F.R.G.

CALL SIGNS	FREQUENCIES	TIMES	EMISSION	POWER
DDH3	3855 kHz	0600-2300	F3C	.8KW
DDK3	7880 kHz	CONTINUOUS	F3C	20 KW
DDK6	13882.5 kHz	CONTINUOUS	F3C	20 KW

TRANS TIME	CONTENTS OF TRANSMISSION	RPM/IOC	VALID TIME	MAP AREA
0520	SURFACE ANAL WITH PLOTTED DATA	120/576	0000	D15
0540	500MB ANAL WITH PLOTTED DATA	120/756	0000	D15
0600	24HR SURFACE PROG (1)/ 24HR 1000-500MB PROG	120/576	0000	D30
0611	SURFACE/850MB TEMP/700MB RH/ 500MB HT-TEMP ANALS/ W 24HR/48HR/72HR PROGS	120/576	0000	D60
0631	850MB HT-TEMP ANAL & 24HR/48HR/72HR PROGS	120/576	0000	D30
0651	96HR/120HR/144HR SURFACE PRESSURE/			

	850MB TEMP/700MB RH/500MB HT-TEMP	120/576	0000	D60
0711	500MB ANAL WITH PLOTTED DATA	120/576	0000	D15
0731	24HR SURFACE PROG (1)/			
	1000-500MB THICKNESS PROG	120/576	0000	D30
0745	NORTH ATLANTIC SURFACE ANAL/			
	W PLOTTED DATA	120/576	0000	V8
0852	NORTH SEA SEA SURFACE TEMP	120/288		V2
0906	ICE CONDITIONS FOR WEST BALTIC SEA			
	AND ATLANTIC (2)(3)	120/288		V1
0922	48HR/72HR SURFACE PROGS	120/576	0000	D30
0933	24HR SURFACE PROG (1)/			
	12HR AMOUNT OF PRECIPITATION (4)	120/576	0600	D30/K15
1000	SURFACE ANAL WITH PLOTTED DATA	120/576	0600	D15
1020	BALTIC SEA ICE CONDITIONS (2)(3)	120/576		V1
1408	NORTHERN HEMISPHERE SURFACE ANAL			
	WITH PLOTTED DATA	120/576	0000	Q30
1430	SCHEDULE (MON)/TEST CHART(TUE-SUN)	120/576		
1520	36HR NORTH ATLANTIC WAVE PROG	120/576	1200	V3
1541	BALTIC SEA ICE CONDITIONS (3)(5)	120/576		V6
1557	SURFACE ANAL WITH PLOTTED DATA	120/576	1200	D15
1758	24HR SURFACE PROG (1)/			
	1000-500MB THICKNESS PROG	120/576	1200	D30
1809	500MB ANAL WITH PLOTTED DATA	120/576	1200	D15
1830	850MB ANAL			
	WITH 24HR/48HR/72HR PROGS	120/288	1200	D30
1845	NORTH ATLANTIC SURFACE ANAL			
	WITH PLOTTED DATA	120/576	1200	V8
1941	SURFACE/850MB TEMP/700MB RH/			
	500MB HT-TEMP ANALS/			
	WITH 24HR/48HR/72HR PROGS	120/576	1200	D60
2001	5 DAY MEAN WATER TEMPERATURE (7)	120/576		P15
2021	SEA ICE OBSERVATIONS (8)	120/576		V4
2042	BALTIC SEA ICE CONDITIONS	120/576		V7
2126	WEST ATLANTIC ICE CONDITIONS (2)(3)	120/288		N
2140	36HR NORTH ATLANTIC WAVE PROG	120/576	1200	V3
2201	SURFACE ANAL WITH PLOTTED DATA	120/576	1800	D15
2241	24HR SURFACE PROG (1)/			
	12HR AMOUNT OF PRECIPITATION (4)	120/576	1800	D30/K15

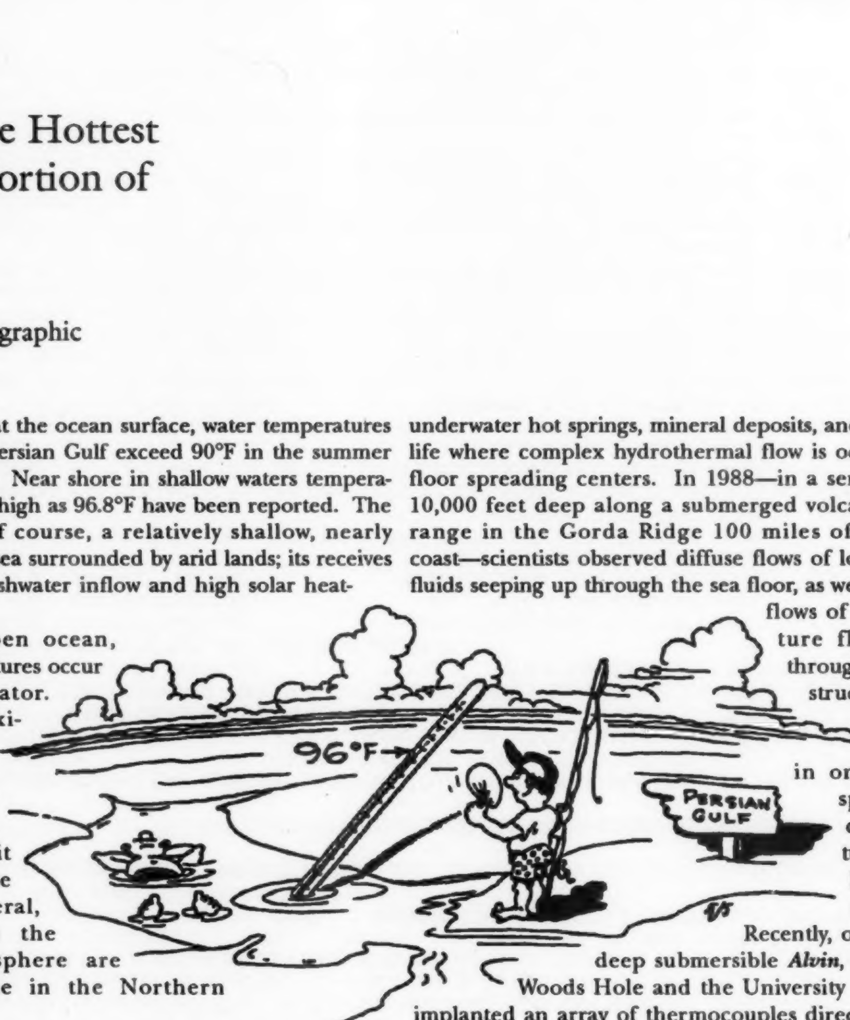
OFFENBACH (MAIN)/HAMBERG-PINNEBERG, F.R.G.
NOTES: 1. SURFACE PRESSURE PROGS WITH FRONTS AND AREAS OF MODEL SIMULATED MID-TROPOSPHERIC CLOUD COVERAGE OF MORE THAN 6 OKTAS WHICH ARE MARKED OFF BY THICK UNDULATING LINES.
2. PRODUCED BY: "DEUTSCHES HYDROGRAPHISCHES INSTITUT".
3. IRREGULARLY, ONLY IF REQUIRED BECAUSE OF ICE CONDITIONS.
4. AMOUNT OF PRECIPITATION (mm) 1800 TO 0600 UTC (0933 TRANSMISSION) AND 0600 TO 1800 UTC (2241 TRANSMISSION).
5. REBROADCAST OF NORRKOPING (ESWI) TRANSMISSIONS.
6. ON MONDAYS ONLY.
7. REPRODUCED ON TUESDAYS AND FRIDAYS ONLY. THE OTHER DAYS WILL BE REPETITION OF THE PREVIOUS CHART.
8. REBROADCAST OF BRACKNELL (EGRR) TRANSMISSIONS.

MAP AREAS: D15 - 1:15,000,000 SAME AS D30 CHART
D30 - 1:30,000,000 40N 081W, 63N 102E, 17N 029W, 27N 033E D60 - 1:60,000,000 SAME AS D30 CHART
K15 - 1:15,000,000 59N 034W, 61N 049E, 35N 011W, 36N 028E P15 - 1:15,000,000 40N 081W, 71N 103E, 18N 029W, 29N 026E Q30 - 1:30,000,000 12N 108W, 07N 125E, 02S 033W, 06S 057E V1 - 1:02,000,000 BALTIC SEA WEST OF DORNHOLM, BELTS AND SOUND, KATTEGAT.
V2 - 1:02,000,000 62N 004W, 62N 012E, 50N 004W, 50N 012E
V3 - 1:15,000,000 52N 110W, 61N 034E, 07N 057W, 09N 018W
V4 - 1:10,000,000 57N 096W, 71N 071E, 38N 048W, 46N 013E
V5 - GULF OF BOTHNIA AND NORTHERN BALTIC SEA.
V6 - BALTIC SEA PROPER.
V7 - WESTERN BALTIC, BELTS, SOUND, KATTEGAT, SKAGERRAK AND LAKE VAENERN.
V8 - 1:15,000,000 38N 100W, 60N 036E, 14N 070W, 21N 013W
N - NO INFORMATION CURRENTLY AVAILABLE.
(INFORMATION DATED (01/1990)

Where is the Hottest Ocean or Portion of an Ocean?

Richard Abram
National Oceanographic
Data Center

Looking at the ocean surface, water temperatures in the Persian Gulf exceed 90°F in the summer months. Near shore in shallow waters temperatures as high as 96.8°F have been reported. The Persian Gulf is, of course, a relatively shallow, nearly enclosed marginal sea surrounded by arid lands; its receives little rainfall or freshwater inflow and high solar heating.



In the open ocean, maximum temperatures occur north of the Equator. The zone of maximum surface water temperature shifts with the season, but only in a few areas does it extend south of the Equator. In general, temperatures in the Southern Hemisphere are lower than those in the Northern Hemisphere.

Below the surface layer ocean temperatures drop to just a few degrees above freezing in the abyssal depths. But not all the sea floor is as cold, quiet, and uninteresting as once thought. In recent years deep-sea dives to conduct research related to plate tectonics have brought back spectacular descriptions and pictures of underwater hot springs, mineral deposits, and exotic animal life where complex hydrothermal flow is occurring at sea floor spreading centers. In 1988—in a series of dives to 10,000 feet deep along a submerged volcanic mountain range in the Gorda Ridge 100 miles off the Oregon coast—scientists observed diffuse flows of low-temperature fluids seeping up through the sea floor, as well as geyser-like flows of high temperature fluids spewing through chimney-like structures up to 10 feet high. Measurements in one of the hot springs indicated temperatures possibly as high as 500°F (260°C). Recently, on a dive of the deep submersible *Alvin*, scientists from Woods Hole and the University of Washington implanted an array of thermocouples directly on top of a seafloor vent off the coast of Washington State. Over the next 46 days, the main portion of the flow showed a stable temperature of 667°F (353°C), while several thermocouples recorded maximum temperatures between 689°F (365°C) and 761°F (405°C). (This is an update of a question that appeared in NODC's *Questions About the Oceans.*)

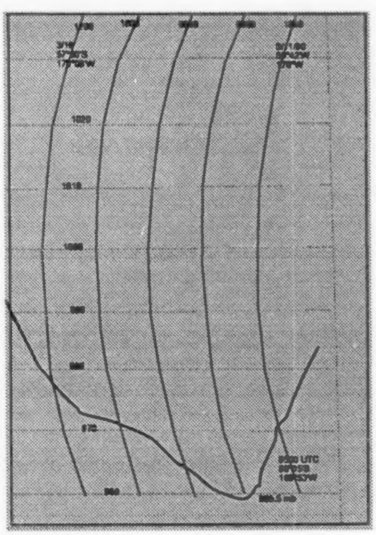
Caroline Island—Part 3

In keeping in tune with the season we decided to run some light reading for summer, along with our regular features. When Josh McDowell sent along his interesting Caroline Island mystery, he mentioned that Gary Mundell, whose sailboat they had discovered, had written an article for *Cruising World* a few years ago. We thought this might make an interesting combination of articles. The people at *Cruising World* were most helpful and with their permission we sought out Gary. We knew his home base was Alaska but there was no current listing for him. Out of desperation we called the only other Mundell listed and fortunately it turned out to be his father, Earl Mundell.

Earl told us that Gary was now working for NOAA aboard the ***Miller Freeman*** — an ironic twist. Although Gary was on leave at the time, Earl was nice enough to relay our message and Gary got back to us just in time to make the deadline. Gary is an Assistant Survey Technician at present. He is going to try to get aboard the ***Surveyor*** for its run to Antarctica in December. He also hopes to sail aboard the ***Malcolm Baldridge*** (formerly the ***Researcher***), which found his boat on Caroline Island. That would certainly complete the circle. Good Luck Gary.

The Whistling 50's

Pete Connors, Port Meteorological Officer from Miami, sent in an interesting barogram from the NOAA ship R103, which was on its way from Pago Pago, American Samoa to Wellington, New Zealand. On March 10, 1990 the vessel ran into a wicked Low, which was centered near 60°S, 170°W. By 0500 UTC on the 11th their pressure had fallen to 958.5 mb near 60°05'S, 169°53'W. This was somewhat lower than the 970 mb central pressure that was estimated on the weather charts. And just who is NOAA ship R103 — the ***Malcolm Baldrige***, of course.



NOAA Weather Wire Service

The National Weather Service has installed a nationwide satellite–based replacement system for broadcasting severe weather warnings, watches and other weather–related information. Called the NOAA Weather Wire Service (NWWS), the new system will deliver information by means of high–speed, low–cost satellite earth stations and will be available at uniform cost to users such as the news media and private forecasters. The Weather Wire is capable of providing information to subscribers throughout North America, regardless of time, weather or geographic location. In addition to the news media and general public, state and local emergency management authorities use the service extensively. NOAA has provided one terminal to a selected agency in each state so that officials can obtain warnings, watches and forecasts that are vital to public safety and well–being.

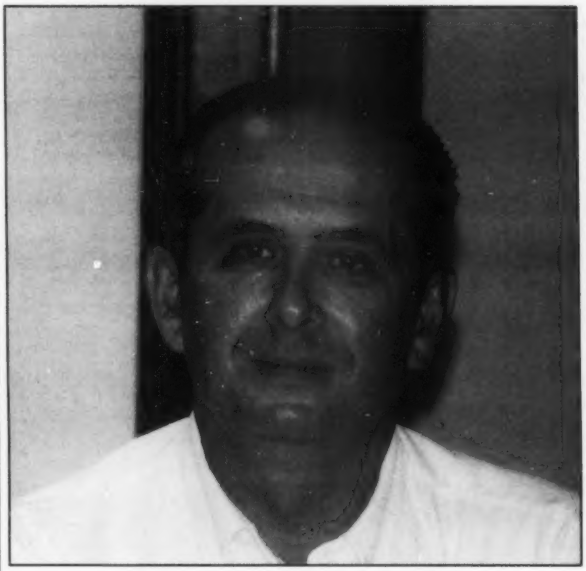
Point Honda Disaster

General Patton's philosophy about studying history so as not to keep repeating past mistakes is particularly apropos to weather and navigation. On September 8, 1923 the U.S. Navy Destroyer Squadron Eleven, less four vessels, left the San Francisco light vessel at 8:30 a.m. for San Diego.

Around 11 o'clock the squadron was aligned in standard formation with Pigeon Point Light on the port beam some 1 mile distant. The speed was about 20 knots. After some simple tactical exercises, in the afternoon, the squadron was formed in column. Visibility while not great, did not interfere with the exercises.

At 8:50 p.m., after checking his position on the chart, the Squadron Commander decided to change course to 090° to make the approach to Santa Barbara Channel. The course change was made at 9 p.m. and 5 minutes later the ***Delphy*** stranded on Perdernales Point (known locally as Point Honda). The Squadron Commander immediately sent warning signals to the vessels astern but, due to the configuration of the coastline, the outlying rocks and the fact that the ships were in formation, six other vessels were suddenly stranded on a rocky promontory at night. The lives of 800 officers and men were in peril. A total of 23 lives were lost and more would have died except for the high degree of discipline and morale in the squadron. The seven vessels were declared total wrecks and later sold as hulks. In the historic photograph below notice the wing of the biplane at left.

Getting to Know Your PMO



George Smith PMO, Cleveland

George Smith is the Port Meteorological Officer for Cleveland, Ohio. His operating area covers the coast from near Detroit, Michigan to Buffalo, New York. George is one of the hardest working NWS employees and one of the friendliest. We appreciate him taking the time for the interview.

MWL: Did you start with NWS as a PMO?

George: No I began as a Meteorological Technician at WSFO Cleveland in June of '82 and was selected for the Supervisory Meteorological Technician on June 16, 1983.

MWL: How about your career before NWS?

George: I entered the USAF on February 2, 1960. After basic I went to the Weather Observer Course at Chanute AFB, IL. My Air Force career covered 22 years, 5 months and 29 days (but who counts), as an Observer, Chief Observer and Forecaster with Air Weather Service. My last assignment was as Technical Advisor to the 146th Weather Flight, Pennsylvania Air National Guard in Pittsburgh. I had assignments in Texas, Illinois, Ohio, Louisiana, Korea, Virginia, Arkansas, New Mexico, Massachusetts, Pennsylvania and Panama. I still miss the Air Force and try to stay in touch, but it was time to move on.

MWL: Do the Great Lakes PMO's encounter different problems than the salties?

George: Yes and No. As far as the VOS Program is concerned, it can be divided into two parts. First of all we work with approximately 65 ships of 14 different companies, belonging to the Lake Carriers Association, which has its offices in Cleveland. Also several non–aligned shipping and towing companies are involved. We work very closely with the U.S. Coast Guard 9th District, which is headquatered in Cleveland and has five groups with, as I count, 48 stations and 11 Coast Guard Cutters. We also work very closely with our Canadian counterparts and Canadian VOS ships. This does not take into account the smaller vessels and small boat interests. In just Ohio and Michigan alone there are over 1 million registered pleasure boats. The Great Lakes have more shoreline than either coast. (By the way We have taken to calling ourselves the North Coast). My area from just above Detroit, MI to Buffalo, NY includes 20 port cities and means a lot of time and legwork. Over 90% of the large VOS vessels are self unloaders and spend a minimum time at the dock (probably 6 to 7 hours average day or night), which makes for some long and late days if you want to visit some vessels. I think it would be fair to say that this is a fairly tight community in which there is a lot of competition, but at the same time there is a lot of cooperation to make the Great Lakes a safer and more profitable area for all mariners.

Our second program area is the large amount of salty vessel traffic on the Great Lakes. A large percentage of these are bulk carriers of many flags and do not routinely visit U.S coastal ports other than the Great Lakes. A U.S. Flag salty is a rare sight. Sadly, although we have recruited a number of these ships and they are very good reporters, there is not enough time to devote to these vessels. Given time I think we could do better in this area.

MWL: Do you have other duties?

George: Yes, I wear two hats. I am also the Supervisory Meteorological Technician for this forecast office. As SMT, I am responsible for the substation program management as well as supervising the meteorological technicians. This entails managing weather observation programs at other smaller area airports and Coast Guard stations in northern Ohio. I also accomplish a large part of the supply function for our office. Dwindling numbers of personnel over the

last couple of years has meant more of my time is spent on shift work and other duties.

MWL: How does the Great Lakes Marine Weather Enhancement Program mesh with the PMO functions?

George: They complement one another very well. The Marine Enhancement Unit, of which the PMO is a part, has done a fantastic job in improving the product, which we provide to the marine user in general and the VOS vessels in particular. The PMO plays a vital role in providing liaison between the enhancement unit, marine disseminators, shipping companies, VOS ships and other marine users. We make sure data flows in both directions.

MWL: How big is the Great Lakes VOS Program?

George: Between the Chicago PMO, Bob Collins and myself approximately 71 Great Lakes U.S. VOS vessels are managed along with a smaller number of Ocean VOS vessels. Our Great Lakes vessels contribute 25 to 30 thousand observations per season. The Canadians have approximately 116 VOS vessels with similar observation return numbers.

George Smith and his son Scott are seen here aboard the USCGC Bramble. George is the young looking one. The Bramble is a vessel in George's VOS Ship program, which enables him to keep an eye on Scott; or possibly the other way around.

MWL: How about your family?

George: My family consists of my wife of almost 29 years, Carol; my son Doug, 26 years old, married and in industrial management and quality control; my son Scott, 23 years old, a graduate of the U.S. Coast Guard Academy; my daughter Kim, 22 years old a graduate of Southeastern Academy and working in the travel industry.

MWL: Do you live near work?

George: We live in North Ridgeville, OH, about a 15 minute drive from my office at Cleveland's Hopkins Airport.

MWL: How about outside interests?

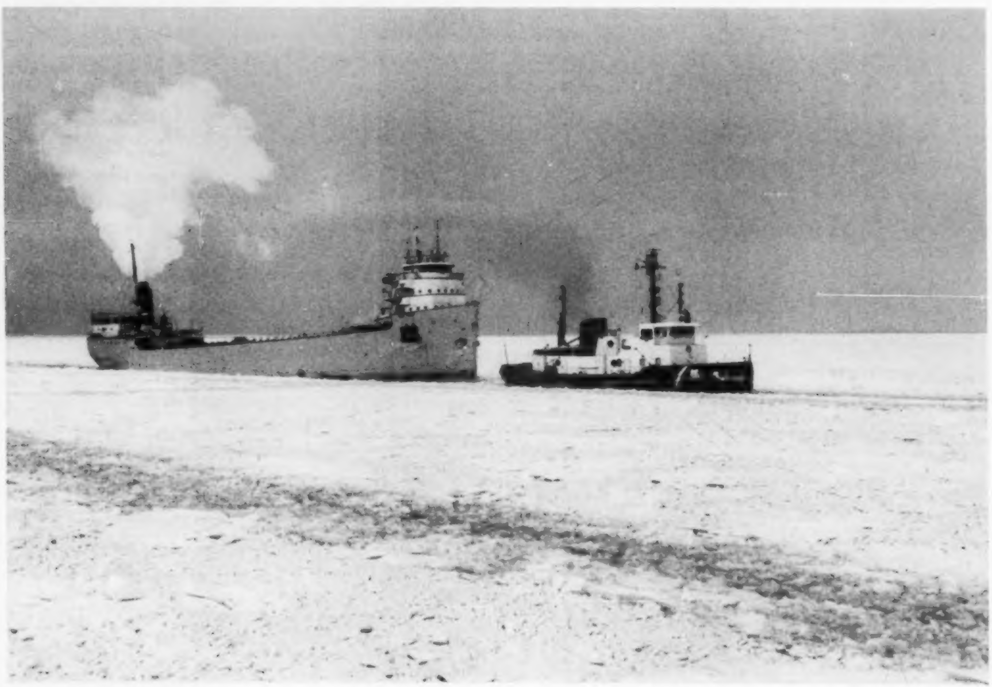
George: Outside of work I keep pretty busy. I love fishing and photography and I am president of the North Ridgeville Lions Club, which provides very satisfying work.

When this column began I had hoped to accomplish two things. One, I wanted to encourage mariners to send in more photographs of atmospheric and oceanographic phenomena at sea. I was always a little envious of the British publication — *Marine Observer* — and the rapport they have with their readers. Two, I was hoping to be able to have a professional photographer write some columns to assist and improve the taking of those photographs. While I am still working on the second, the photos have been coming in, which is encouraging. It indicates that there is an interest in weather and photography among mariners. The following photographs cover a variety of topics and I encourage everyone to send in their photos. In this issue the contributors are Frank Stone Wareham 2d Mate on the LNG *Capricorn*, 2d Officer Ranjit R. Raje from the M.T. *Chevron Meteor* and our old friend Lt. Edward Sinclair, Commanding Officer aboard the *USCGC Biscayne Bay*.

Polarizing Filter Tip

A polarizing filter can be a very handy accessory to your camera. It deepens blue skies, intensifies colors and reduces reflections. It is most effective when used at right angles to the arc of the sun. By rotating the polarizing ring you can see, with a single lens reflex camera, just what the effect will be. One word of warning is in order about the use of polarizing filters with automatic focusing cameras and lenses. Autofocus and autoexposure systems can have trouble handling polarized light and may require a circular polarizer. This should be mentioned in your camera manual.

This spectacular wave photograph was shot by Frank Stone Wareham aboard the LNG Capricorn. It was taken during Typhoon Percy in June of 1990.



Lt. Edward Sinclair sent some shots of the ***Biscayne's*** *operations in March in the icy Straits of Mackinac. The vessel being assisted is the steamer* ***E.M. Ford,*** *the oldest commercial vessel being operated on the Great Lakes. She was built in 1898 and is owned by Huron Cement. Left, is a sunrise photo of the cutter* ***Bristol Bay*** *leading the* ***E.M. Ford.*** *To the right, the* ***E.M. Ford, Bristol Bay*** *and the tug* ***Malcolm*** *make their way through the ice at night. Lower left, the* ***Bristol Bay*** *and the* ***E.M. Ford*** *push on during daylight hours. In the lower right the crew of the* ***Biscayne Bay*** *poses for a team photo in front of the team bus after a broomball game. All photographs were taken by Lt. Edward Sinclair.*

The polaroid photograph at the far right was taken by Ranjit Raje 2d Officer aboard the ***M.T. Chevron Meteor,*** *while they were enroute from Philadelphia, PA to Muanda, Zaire. They were crossing the Gulf Stream on the 26th of February 1990. The sea fog was experienced throughout the*

crossing of the Gulf Stream, at times causing a reduction in visibility to just 100 meters (330 feet). At the time of this photo the dry bulb and wet bulb temperatures were 1°C while the sea temperature was 22°C.

Sea and Swell

Martin S. Baron
National Weather Service
Silver Spring, MD 20910

With the possible exception of the wind, nothing affects the mariner more than the waves of the sea. The maritime section of the Ships' Synoptic Code, which begins with the maritime data indicator 222, contains four sea and swell groups, to report the local wind–driven sea and up to 2 different observed swells. To report these groups there are three wave characteristics to be estimated— wave direction, period, and height.

Reporting Sea And Swell ($2P_wP_wH_wH_w$ $3d_{w1}d_{w1}d_{w2}d_{w2}$ $4P_{w1}P_{w1}H_{w1}H_{w1}$ $5P_{w2}P_{w2}H_{w2}H_{w2}$)

Sea wave direction. and swell wave direction ($d_{w1}d_{w1}d_{w2}d_{w2}$), like the direction of the wind, are the true directions from which the waves are coming. There is no space in the synoptic code for reporting sea wave direction, because it is assumed to be the same as the wind direction (dd). This is true most of the time, but if the wind direction is changing, as when a trough or front passes your vessel, the sea wave direction will lie at an angle to the wind direction. There may be two distinct sets of sea waves, the angle between them being the difference in wind direction on either side of the trough. There is no provision in the synoptic code for reporting two sets of sea waves. If such a situation exists at the time of observation, report the characteristics (period and height) of the best formed sea waves. Such a sea can be very chaotic and hazardous.

Report swell wave direction using the coded wind direction table available from the Ship's Code Card or NWS Observing Handbook No. 1 Table 2.10

Sea wave period (P_wP_w) and swell wave period ($P_{w1}P_{w1}P_{w2}P_{w2}$) are the time intervals, expressed in seconds, for successive crests, or troughs, to pass a given point. To measure wave period, a stopwatch is desirable. Choose a distinctive patch of foam or a small object floating on the water, and note the time it takes the foam or object to go from one crest to the next. Repeat this procedure until several oscillations have been observed. Calculate and report the average period that you have observed.

"In the MWL *Selected Gale and Wave Observations*, I've noticed some vessels are reporting very long sea periods, of 8 seconds or more. This is probably swell, rather than sea."

There is no code table for period— it is reported in actual seconds. Confusion between sea and swell can occur when the local wind direction happens to be (by chance) aligned with the incoming swell. Seas with very long periods can occur, but only when the wind has been blowing from the same direction for a very long time (days) over a long stretch of open sea. This situation could account for many of these reports.

Sea wave height (H_wH_w) and swell wave height ($H_{w1}H_{w1}H_{w2}H_{w2}$) are measurements of the vertical distance between the top of a crest and the bottom of an adjacent trough. These estimates depend on the skill and ingenuity of the observer. Use a standard of height, such as the height of a man, bulwark, forecastle, or other well known dimension of the ship. There is a tendency to overestimate the height of short waves, and underesti-

mate the height of longer waves. Wave systems always contain waves of varying heights— report the significant wave height— the average height of the larger, better formed waves in your visual range.

The wave height code is in units of half meters. See the Ships' Code Card or table 2.26 in NWS Observing Handbook No. 1 for the wave height code table.

The distinction between sea and swell waves is well known to mariners. Sea waves are waves produced by the local wind, either at the time of observation, or in the recent past. Swell waves are waves that have traveled into your area after having been generated by distant winds, sometimes thousands of miles away. In general, swell waves are long in comparison to sea waves, because swells of short wavelength have less energy, and tend to dissipate quickly. The longest swells travel the greatest distances. Long swells also travel faster than shorter waves; the speed, in knots, for both sea and swell waves, equals 3.1 times the period, in seconds. Wavelength, in meters, equals 1.56 times the square of the period, in seconds. Because of their greater speed, longer swells will travel ahead and give advance warning of an approaching storm. As swell travels, it's height decreases. Investigations have shown that after traveling 1200 miles, a swell will lose half its height.

Except for a very small number of wave recording instruments (on some buoys, weatherships, lightships, and stationary platforms), the vast majority of wave reports are made visually from aboard ship. There are two main uses for wave data. First, real–time wave data is needed to forecast future wave conditions. This is particularly important in connection with ship weather routing. Real–time wave data is also useful as a forecast guide — the onset of swell can serve as a clue to the approach of a tropical storm. Second, large numbers of wave reports are required for the establishment of *wave climatologies*, which are used in, among other things, — the design of ships, the orientation and construction of harbors and breakwaters, and the control of coastal erosion and silting. Wave reports also provide valuable information during investigations of storm damage.

Nature's Tropical Cyclone Warnings

This issue of the Mariners Weather Log (MWL) coincides with the Northern Hemisphere peak tropical cyclone period (August and September), when sea surface temperatures in the tropical oceans have reached their annual peak. Ship's officers should exercise constant vigilance to ensure they are not caught unawares by a tropical cyclone. Fortunately, nature provides several early warning signs for the alert observer; whenever possible, the National Weather Service, and other meteorological services provide forecasts and warnings for tropical cyclone development.

Natural tropical cyclone warnings at sea include:

(1) The Barometer — As I reported in the spring MWL (page 42), when in the tropics, your barograph trace is a very good indicator of tropical cyclone development. As it develops or nears your vessel (within a few hundred miles), it causes a disruption in the normally very regular diurnal pressure variation pattern seen on your barogram. Typically, pressure peaks at 1000 and 2200 hours, and bottoms out at 0400 and 1600 (local time), with daily ranges from about 3.0 mb near the equator, to about 1.7 mb at 35° latitude. A departure from the usual diurnal variation indicates there is a risk of a tropical cyclone forming, and under these circumstances, a special weather report, using the prefix SPREP before the BBXX indicator, should be sent.

(2) Swell — Since they originate in the heavy seas created in a storm area, the onset of swell waves can indicate the approach of a tropical cyclone. If there is no land between the storm and the ship, a long swell will come from the direction of the storm center. The presence of swell can also be used to distinguish between a local squall, and an approaching organized storm system. A threatening sky, with no swell present, is indicative of a short lived, bad–weather event, such as a thunderstorm, or squall line. However, advancing and thickening storm clouds accompanied by increasing swell suggests an approaching tropical cyclone with a large area of strong winds.

The appearance of swell can have other meanings. On the U.S. West Coast, a prominent westerly swell can indicate the approach of a broad region of strong westerly winds (which may last for one or more days), rather than a storm center. On the U.S. East Coast, an easterly swell is often left by a storm which has already passed by, a vestige of the storm's power. In any marine area, a swell with a period of more than about 6 seconds, may be produced by a gale or tropical cyclone at a great distance and represents little threat to you. Swell waves with the long periods and wavelengths can travel very large distances and remain intact. The shorter swells have less energy and do not survive such long distances.

(3) Clouds — The appearance of cirrus is often the first warning of a tropical cyclone, even in the early stages of development. The cirrus appears when the storm is 300 to 600 miles away. If it thickens to cirrostratus, and then to altostratus and nimbostratus, a tropical cyclone may be approaching. If this cloud sequence is accompanied by

increasing swell, and a barometric pressure anomaly, a tropical cyclone is almost certainly on it's way.

(4) Visibility — Exceptional visibility frequently precedes a tropical cyclone.

(5) Wind — An appreciable increase in wind force should also be regarded as a possible indication of the approach of a tropical cyclone, especially when one or more of the above warning signals is also present.

New PMO In Honolulu

Lt. (jg) Jeff Brown, of the NOAA Corps, is the New PMO in Honolulu, HI, replacing Pete Celone, who accepted a position with the National Ocean Survey in Washington, D.C. Jeff was born in Rome, Georgia, and spent his childhood in the southern Appalachian Mountains. He has a B.S. degree in physics from the University of Tennessee at Chattanooga. He has been with the NOAA commissioned officer corps since 1987, and has served as an officer/scientist aboard the NOAA ships ***Davidson*** and ***Discoverer***. He has participated in scientific investigations near the Laotion Islands, in the Gulf of Alaska, and off the California Coast. In 1989, he took part in the east Pacific RITS/C02 cruise, on the NOAA ship ***Discoverer***.

New PMO in Kodiak

Lee Kelly is the new PMO in Kodiak, Alaska, replacing Bob Bonner, who has transferred to another position within NWS. I'll have more information about Lee and a photograph in the next MWL.

New Baltimore PMO to be Selected

Bob Melrose, who was a PMO for over 14 years, first in Panama and, for the past year, in Baltimore, has accepted a position (promotion) in the observation/forecast dissemination program at the NWS office in Baltimore. Although Bob has begun the new position, he is still processing completed observation forms and ship supply requests. Bob claims that he already misses the VOS program.

PMO Meeting in September

The annual meeting of Port Meteorological Officers will take place this September in Seattle, Washington. Please contact your PMO with comments and suggestions for improving the VOS program. Your ideas will be brought to the conference table.

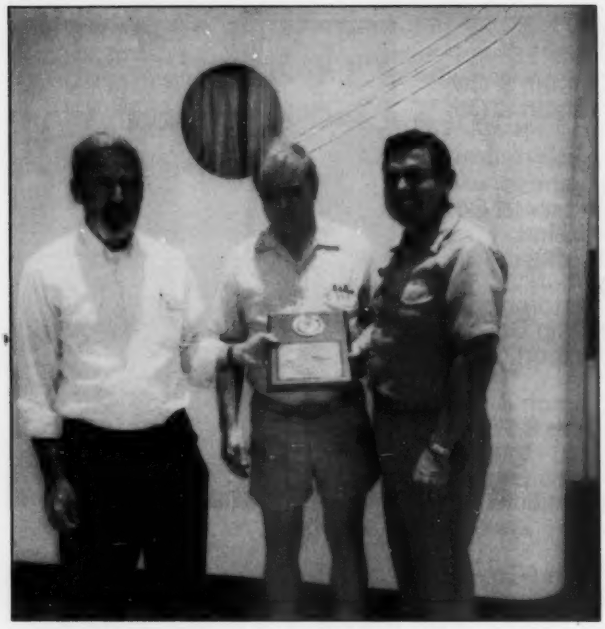
Merchant Marine Academy Obs

Observing and reporting weather at sea is valuable to all mariners. The National Weather Service recently provided the U.S. Merchant Marine Academy with observation equipment to be used in training cadets in marine meteorology and real-time observations. This training will benefit both future merchant marine officers and the weather service by improving the observational accuracy and thereby forecast reliability. Below, the irrepressible Vince Zegowitz, Marine Observation Program Leader of NWS, and Captain Richard Stewart, Head of the Department of Marine Transportation, at the U.S. Merchant Marine Academy shake hands to complete the deal.

New Recruits April to June 1990

Alligator Pride	ELJO8	Williams Diamon & Co.
Alligator Symphony	3EKY7	Williams Diamon & Co.
Atlanta Bay	WRA9063	AM
Axel Maersk	OXSF2	Maersk Line
Bardu	ELHF8	Torvald Klaveness
Black Peral	C4EC	Williams Diamon & Co.
Bonn Express	DGNB	Hapag–Lloyd Inc.
Bruma I	3EZH3	Oceanwide Maritime
Bum Dong	D7XU	Panobulk America
Carman	SJUC	Wallenius Motorships
CGM Provence	DEGM	Kerr Steamship Co.
Columbia Bay	WRA4008	Amoco Transport Co.
Contshipspain	OXON2	
Donaire	DUYV	Williams Diamon & Co.
DYVI Skagerak	LAEL4	Seatec Marine A/S
Eternity	9VOF	Denholm Ship Mgmt Ltd.
Fantasy	ELKI6	Carnival Cruise Lines
Fuji	ELMV6	Southeast Maritime Co.
Green Harbour	KIBJ	
Gulf Spirit	ELIH8	
Hanjin Masan	D8MO	Hanjin Shipping Co.
Hansa Rostock	LAXT2	Kosmos Ship Mgmt.
Heidelberg Express	DEDI	Hapag–Lloyd Inc.
John A. McCone	5LDM	Chevron Shipping Co.
John Young	ELNG9	Chevron Shipping Co.
K. Topic	3EYT7	Transmarine Navigation
Koyagi Spirit	ELIQ3	Teekay Shipping Co.
Lake Erie	P3DD3	Biehl & Co.
Masslot	PFRS	Seachem Agency
Maersk Commander	GHZY	Maersk Line
Maersk Pine	GKJJ	General Steamship
Corp.		
Majestic Maersk	OUJH2	Maesk Line
Mar Esmeralda	3EQY6	Biehl & Co.
Mar Transporter II	TCSX	National Weather
Service		
Melanie	3EEV6	Compass Marine
Nedlloyd Madras	PGDY	Nedlloyd Lines
Negros Sampaguita	DVCK	International Shipping
Ocean Highway	ELKD6	Kerr Steamship Co.
Ocean Lily	3EQS7	K Line America Inc.
Pelander	ELEG8	NYK Line
Phillips Venezuela	D5TK	Interocean Steamship
Pioneer Spirit	ELHP2	Teekay Shipping Co.
President Ibanez	3EIX2	Containership Agency
Rainier	D9BW	General Steamship
Corp.		
Richmond Bay	WRA7929	Amoco Transport Co.
Shoshone Spirit	ELIP5	Transmarine Navigation
Skanderborg	OYRI4	Barwil Agencies Inc.
Star Grindanger	ELFT9	Star Shipping Inc.
T.S. Empire State	KKFW	SUNY Maritime College
Tallahassee Bay	WRA4829	Amoco Transport Co.
Ticao Sampaguita	DURV	International Shipping
USNS Titan	NCEV	Commanding Officer
Viking Ace	ELMR7	Strachan Shipping Co.

Upon entering the VOS program the Green Master and Sanko Prelude receive plaques. Dave Bakeman, Seattle PMO (above) presents this token to Captain Adriano Dimaano of the M/V Prelude. Below Captain Song Yang Ki and 2d Officer Jo Sang Heon of the Green Master display their plaque.



What would be more fitting than for the NOAA ship Malcolm Baldrige, which has been featured throughout this issue, to receive an award. It wasn't planned but it did happen. Receiving the plaque for its outstanding contribution to the VOS ship program (upper left) are Chief Survey Technician Robert Hopkins (center) and Acting Commanding Officer Ron Sellers (right). Pete Connors, PMO Miami, is doing the honors. In the upper right, Pete Connors presents to Captain Renato Piovano of the Celebration, a plaque for their outstanding contribution to the program. The Great Lakes are not without their outstanding ships either. Below left the Wilfred Lykes's award is presented to (left to right) 3d Mate Jay Haiser, Captain Riley Ward and 1st Mate Pete Plimpton. Mike Miller, the 2d Mate was not available and the modest Bob Collins was behind the camera, a position that we rarely find Jim Nelson (PMO, Houston) in. Once again (bottom right) Bob Collins is the photographer as U.S. Steel's Edgar B. Speer receives and outstanding award. Left to right are 1st Mate Tom Lanthier Sr., Captain Francis Altman and 3d Mate John Downey. Missing are Scott Moore and P.W. Anderson.

*Bob Novak, PMO San Francisco, presented several awards this past quarter. In the upper left Captain M. Michaelsen of the **Sealand Enterprise** receives an award for the ship's outstanding effort in recording both surface and bathy (XBT's) observations. She averaged nearly one observation per day during the past year. Other presentations by Bob were to the Fritz Minder (upper right), Master of the pilot vessel **San Francisco** and Robert Porteous, (lower left) Master of the pilot vessel **California**. These awards were given because these ships have collectively take 2880 observations per year and have been doing so without fanfare for the last quarter of a century. The observations are of such value that they are plotted and used routinely by the San Francisco Forecast Office. The reports, which are received every 3 hours, are also transmitted over NOAA Weather Radio. How about a pretty face just for a change of pace from all these mug shots? Below right is Joanne Hutchinson, with the **Evergreen** in the background. Joanne is part of the new forecast group in Washington, DC that is taking over the forecasts from the San Francisco Office. Accompanied by Dave Bakeman, Joanne visited ships and shipping companies looking for ways to improve radio and fax products.*

Attention to Detail

This story comes from PMO Bob Collins out of the Chicago office.

One of the best parts of being a PMO is meeting all the interesting people that make up the Voluntary Observing Ship program. Getting to know a little bit about them can be a real eye–opener.

Take Tom Lanthier Sr, first mate aboard the Edgar B. Speer. I was aboard specifically to present the Captain and crew with their 1989 VOS award for outstanding service. While carrying out this task, I got to talking with Captain Altman and Tom about different hobbies that people get involved in when they are on board ship. I came to find out that Tom makes model boats. Not the kind that you put together from a kit, but those you actually build from scratch.

I asked Tom about his hobby and he was nice enough to show me a model he was working on at the time. The model is a tug similar to the one shown in the photograph. He started this hobby back in 1966. He has completed four different lake type tugs and his models include salties. Tom draws his own blueprints and builds them accordingly. They are powered with small electrical motors. He has completed 18 models to date and as you can see a lot of time, patience and skill goes into this hobby.

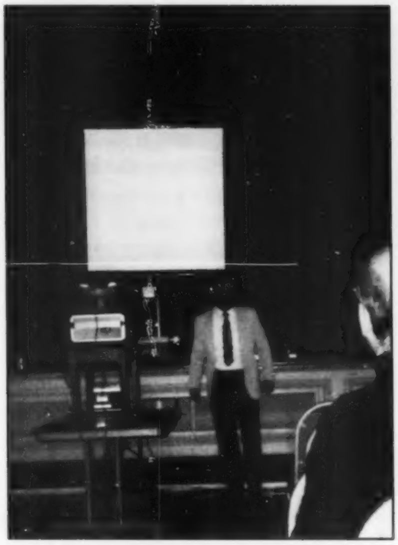
Tom Lanthier, Edgar B. Speer

Chicago Marine Seminar

The National Weather Service Forecast Office in Chicago held a marine seminar on March 17, 1990 at the South Shore Cultural Center along Chicago's beautiful lakefront.

Several speakers took part in the seminar. Ray Waldman, the MIC/Area Manager for Illinois presented opening remarks and an overview of the program. Bob Somrek MIC of NWS Chicago was the Master of Ceremonies.

Bob Somek, DMIC Chicago, NWS



Bob Collins, PMO, NWS Chicago

Richard Koeneman, Lead Forecaster, NWS

Joe Pecoraro, Chicago Park District

Kirk Kliest, Chicago Park District

The program began with the Chicago Park District Beaches & Pools Unit discussing the effects of weather and environment on lakefront facilities. Joe Pecoraro and Kirk Kliest did the honors. An interesting tidbit was that 17 million people used the guarded beaches along the shore and there were no drownings.

Richard Koeneman, Lead Forecaster NWS Chicago, discussed the effect of various weather regimes and phenomena on the recreational boaters. The Coast Guard put on a program consisting of slides and an audio tape depicting many unsafe boating practices that occur on the lakes each season. It is hard to understand why a small sail or power boat would want to challenge a 1000–foot vessel for right–of–way. Guess who wins?

Bob Collins, PMO Chicago, presented a slide program that covered the Voluntary Observing Ship (VOS) program and the MAREP program. Also covered at this time was NOAA Weather Radio and its significance to both recreational and commercial boaters in the dissemination of forecasts and warnings that pertain to marine interests.

Ray Waldman returned to make the closing comments. The feedback from the 70 people that attended was positive. Many suggestions were made and it should make for an improved program next time.

Closing Note

On a sad note, in case you haven't noticed, there is not a photo of Jim Nelson, PMO Houston, to be found anywhere in this issue. It certainly isn't the same without that smiling face. He did call at the last minute in hopes of air expressing one to us, but alas it was too late to make the deadline. However, watch out next issue.

South Pacific Ocean Tropical Cyclones

Staff,
Fiji Meteorological Service

Tropical Depression in Coral Sea (former T.C. Felicity) December 18– 20 1989

Arveen K. Singh

A depression formed in the Gulf of Carpentaria, along a slow moving monsoonal trough, around 0600 UTC on the 14th. It rapidly attained tropical cyclone characteristics and was named Felicity by the Brisbane Tropical Cyclone Warning Center. Felicity moved onto the Northern Queensland peninsula and weakened significantly over the next few days, as it encountered the effects of land. After crossing Queensland, the system moved into the Coral Sea. With the restoration of a source of moisture, it began deepening rapidly. The system acquired storm intensity by 2100 UTC on the 16th. At this stage a ridge of high pressure was slowly moving into the Tasman Sea, causing a surge of southeasterlies to the south of the depression. The depression was estimated to have reached its peak intensity around 1200 UTC on the 17th, with average winds up to 60 knots near the center. Gales were estimated out to 150 miles from the center in the southwestern semicircle and within 60 miles in the northeastern semicircle. After this, the upper trough started to weaken. The depression remained downstream of this trough, thus, maintaining its intensity for a while longer. After 1800 UTC on the 18th, as the system moved farther toward the southeast, it underwent large vertical shearing and began to weaken.

At 0000 UTC on the 19th, the depression was positioned close to 160°E, and was about to enter Nadi's area of responsibility for issuing maritime warnings. At 0300 UTC on the 19th, it was downgraded to gale intensity. By this time the upper–level cloud had almost completely sheared off from the low level circulation. The depression began curving toward the south southeast. Around 1500 UTC on the 20th the depression moved south of the 25°, where it dissipated rapidly.

Willis Island reported average winds of 55 knots for a brief period, around 2100 UTC on the 16th, which is expected to have caused significant damage to vegetation and weaker structures. Otherwise the system spent almost its entire lifespan over the ocean, away from any land areas.

Tropical Cyclone Nancy January 31–February 28, 1990

Neville L. Koop

A surge in the northeast trade winds north of the equator, and the Southern Hemisphere's northwest monsoon, during the last week of January, led to the South Pacific Convergence Zone (SPCZ) and the northeast Australian monsoonal trough becoming active after a prolonged period of dormancy. This activity spawned two tropical depressions. The first, over the Coral Sea, was to become Tropical Cyclone Nancy, while the second became Tropical Cyclone Ofa. Winds around the Coral Sea depression quickly increased and gales were evident in the southwest quadrant by 1400 UTC on the 27th of January. At this time the depression was moving slowly toward Australia. The system began to be influenced by unfavorable conditions in the upper atmosphere and intensification was halted. It then weakened and slowed.

Winds remained below gale force for several days until a trough in the upper atmosphere approached the depression from the west on the 29th,

providing favorable conditions for development. The combination of upper northwesterly steering flow and ridging over the Tasman Sea, steered the system steadily east southeastward, and it redeveloped as winds once again increased to gale force. The depression gained tropical cyclone characteristics some 36 hours later and was named Nancy at 0000 UTC on the 31st of January.

At about this time, Nancy began moving around the southern extension of the upper trough, changing its path toward the south, and then southwest, as the cyclone became embedded in the northeast flow on the equatorward side of the ridge. This track continued for some 12 to 18 hours as the cyclone approached the Australian coast. However landfall was not made, Nancy slowed down and its track became erratic as it came within 30 miles of the coast. The change in motion was accompanied by a marked reduction in convection about the cyclone. However there was no associated decrease in wind intensity as Nancy maintained a strong low level circulation.

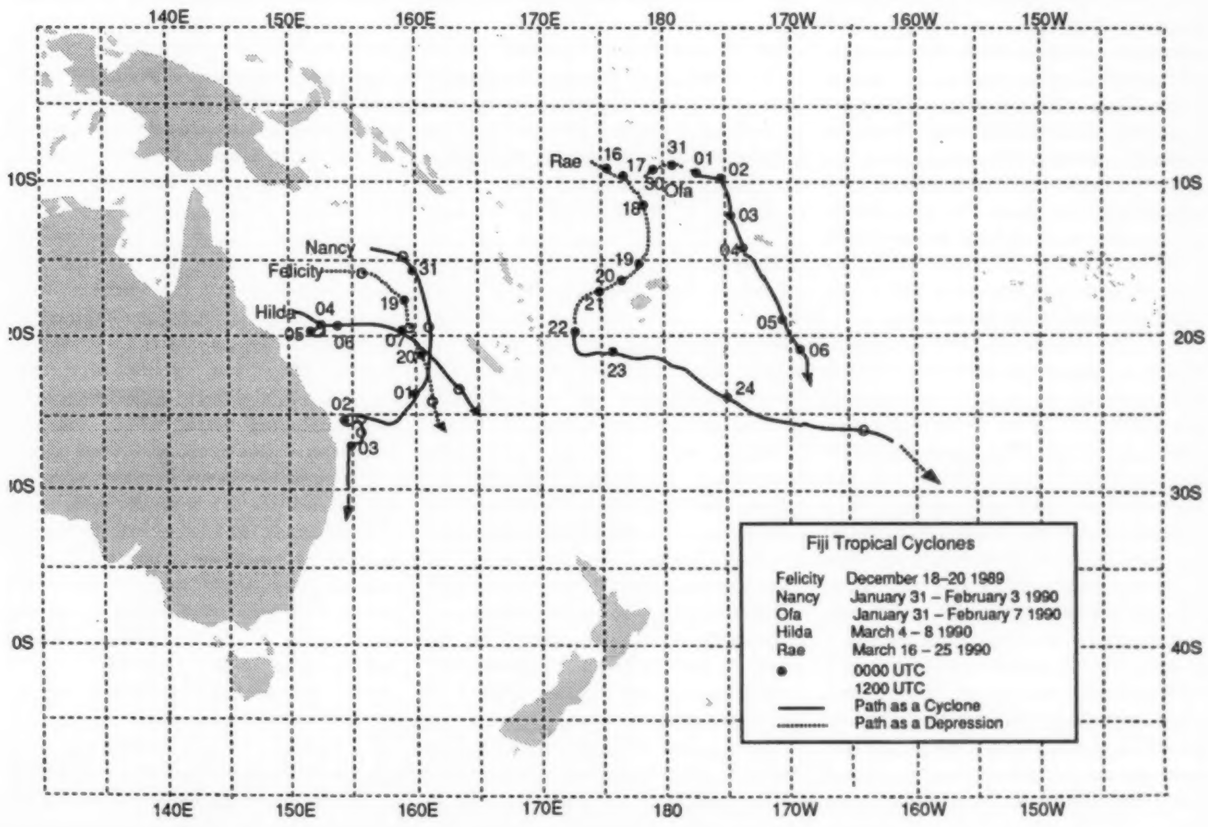
After completing a small clockwise look near Brisbane, Nancy moved southward following the warm water of the East Australian Current.

Tropical cyclone Nancy spent its formative and mature stages over the open ocean and did not affect any land areas. As Nancy approached Australia during the latter stages of its life, it caused widespread heavy rain over coastal regions of Queensland and New South Wales. The resulting floods led to 5 deaths, due to drowning, and caused significant damage to roads and bridges.

Tropical Cyclone Ofa
January 31–February 7, 1990

Staff

A shallow depression formed within the South Pacific Convergence Zone (SPCZ), over Tuvalu, on the 27th of January 1990. In the following days, the system remained slow–moving, close to Funafuti, with little development taking place. By early on the 30th, pressures near the depression's center began to fall rapidly and the cir-



culation began to organize. At 0600 UTC on the 30th, the central pressure was estimated at 995 millibars with average winds of about 30 knots close to the center. The system continued to deepen with a subsequent increase in organization. By late on the 31st, the system had acquired tropical cyclone characteristics and was named Ofa by the Nadi Tropical Cyclone Warning Center (TCWC). At this time Ofa was about 180 miles east of Funafuti. Winds close to the center were estimated at about 40 knots.

From the time the system was named it developed steadily, reaching storm intensity in less than 12 hours and hurricane intensity within 36 hours. Ofa passed about 60 miles west of Savai'i Island, in Western Samoa, between 1000 and 1800 UTC on the 3d. The system reached peak intensity around 1200 UTC on the 4th, with maximum average winds estimated at 100 knots close to the center. Storm force winds extended to about 90 miles and gales to about 250 miles from the cyclone's center. It maintained this intensity for about 24 hours as it continued southeastward. Ofa passed within 30 miles west of Niue around 0300 UTC on the 5th. The minimum pressure recorded at Niue was 962.4 millibars at 0300 UTC that same day.

As Ofa passed Niue, it began to show a slight weakening trend. Subsequently, it curved slowly toward the south and slowed as it crossed into Wellington's area of responsibility, just before 1800 UTC on the 6th. At this time Ofa was still very intense with maximum average winds estimated at 75 to 80 knots close to its center. The system weakened rather fast as it encountered shear from strong upper-level winds and cooler waters.

Tropical cyclone Ofa brought winds of gale strength or stronger and very heavy rainfall to six different countries, resulting in damage ranging from moderate to very severe. Storm tides (combined effect of storm surge and high tide) from the cyclone were the major cause of destruction.

The total extent of the damage in the individual countries is not clearly known yet, but the combined estimate is likely to reach almost $180 million. Reports of damage received at the Nadi TCWC, show the impact of the cyclone to be most severe over Western Samoa, which experienced a major cyclone for the first time in more than 20 years. Elderly people from Western Samoa, and from Niue, described the fury of Ofa as something which they had never experienced in their lifetime.

Cyclone Ofa affected Western Samoa from the 1st to the 3d of February. The meteorological stations at the Apia Observatory and at Faleolo Airport on Upolu began to report average winds of gale force from the night of the lst (local time). Rain became widespread and heavy at the same time. As the winds increased the next day, communication between Western Samoa and the outside world was lost, except for contact with a Polynesian Airline Boeing 727 aircraft standing on the tarmac at Faleolo Airport. The Apia meteorological office was hit by high seas at 10:45 a.m. on the 2d (Samoa time) and had to be abandoned due to rising waters. A few hours later, the office was destroyed completely. The station at Faleolo also suffered damage and lost communication with Nadi for about 24 hours. Winds over Western Samoa became very destructive, with average speeds reaching 60 knots gusting to over 80 knots. Rain became continuous and very heavy, while huge waves and sea spray, resulting from storm tides, flood-

Wind and Pressure Reports From Various Meteorological Stations During the Passage of Cyclone Ofa

Station	Maximum Average Wind (knots) time (UTC)	Maximum Gust (knots)	Lowest Pressure (millibars)
Niue			
Alofi	60 at 05/0600	88	962.4
Samoa			
Apia	60	97	986.1
Pago Pago	–	93	989.2
Tonga			
Keppel	90* at 04/0600	–	974.1
Niuafoou	44 at 04/0000	–	990.1
Vavau	35 at 05/0000	–	991.0
Tuvalu			
Funafuti	36 at 01/0200	46	997.6
Niulakita	47 at 31/2137	68	998.6
Nui	40 at 01/0900	50	1002.3
Nanumea	35 at 01/0600	40	1002.6
Wallis	38 at 02/2330	56	989.9

*Over estimated

ed low-lying coastal areas, adding to the already extensive flooding caused by the heavy rain. Destructive winds lasted for almost 24 hours and the heavy rain for several hours longer.

The combined effect of high winds, heavy rains and storm tides created an impact not experienced in Western Samoa in more than 100 years, and left the whole population in a state of terrible shock and distress. Reports reaching Nadi indicated that all of the 330 villages in the islands received at lease some damage, with the northern coasts of Upolu and Savai'i being the worst hit. Roofs were peeled away, walls knocked down, trees felled, and roads, bridges and powerlines were badly damaged. Storm tides caused even more damage, washing off about 80 percent of the northwestern coastlines of the two main islands, reshaping them and creating several islands of coral debris near the reef line. Meteorological records and equipment at the Apia Observatory were ruined when huge seas struck the beachfront facility.

A total of seven lives were lost, most of them washed away by waves or killed by flying debris. According to a preliminary estimate of the damage, the cyclone cost the country about $130 million.

Ofa affected American Samoa about the same time as it whipped Western Samoa. However, because the cyclone center passed quite some distance away from American Samoa, only marginal storm force winds affected this group. As a consequence, the impact and resulting damage over American Samoa was less than that on Western Samoa. Nonetheless, the extent of damage the country suffered was also severe.

The eye of the cyclone passed about 140 miles southwest of Tutuila Island, in American Samoa, on the evening of the 3d (Samoa time). The winds became very gusty and average speeds reached gale force by 1200 UTC on the 3d. Around 0500 UTC on the 4th, the winds peaked at Pago Pago, with maximum average speeds reported at 53 knots. The maximum gust was 93 knots, which occurred at 0119 UTC on the 3d. The auxiliary power at the station failed around 2100 UTC and contact with Nadi was lost completely between 0800 and 2000 UTC on the 4th.

Preliminary estimates of the damage to American Samoa was about $32 million. The principal destruction was to houses, the electrical system and to agriculture. Coastal areas and villages in the northern part of the islands were most severely affected. Heavy rain and huge seas washed away sections of roads and damaged bridges, buildings, and other structures. However, no loss of human life was reported from American Samoa.

The center of cyclone Ofa passed closest to Niue (about 30 miles to the west) during late afternoon of the 4th (Niue time). Luckily, however, the cyclone had started to weaken by then. Officials in Niue had taken heed of the advance warnings from Nadi and seemed well prepared to face the fury of Ofa. Soon after 1800 UTC on the 4th, winds became strong and gusty over the island and reached gale force by 2300 UTC.

As the eye of Ofa passed close to Niue, destructive hurricane force winds lashed the island for several hours. Gigantic seas, resulting from storm surge, swept over the northern and western coastal areas. Virtually all landings to the sea were washed away or damaged badly by huge seas. There was considerable damage to hospital buildings, the island's hotel, roads, houses, churches and other facilities for the public. Due to the damage to powerlines, electricity was out for about 24 hours. Most of the islands private water supply tanks were contaminated by salt water and declared unsuitable for drinking. Luckily, there was no loss of life or serious injury. The total loss from the cyclone was estimated at around $2.5 million.

In Tonga, worst hit were the islands of Niuatoputapu (Keppel) and Tafahi, which were closest to the path of Cyclone Ofa. The meteorological station at Keppel estimated a maximum wind gust of 90 knots around 0600 UTC on the 4th.

Niuatoputapu and Tafahi suffered severe damage to houses, church buildings, coconut plantations, food crops and other vegetation. Only one death was reported. Preliminary estimate of the damage from the cyclone stood at about $3.2 million.

Ofa passed about 180 miles west of Swains Island around 1800 UTC on the 2d. The islands in the Tokelau Group experienced strong to gale force winds and heavy rain from the cyclone. According to reports, sea walls around the atolls of Nukunonu, Atafu and Fakaofo were washed away by high seas, and up to half the number of houses on the atolls were wrecked. Furthermore, up to 80 percent of the breadfruit and coconut plantations were torn down by winds. There was no report of death or serious injury in Tokelau.

Tropical Cyclone Hilda
March 4–8, 1990

M. Manoj Singh

A shallow depression developed about 400 miles east of Townsville, around the 4th of March. The depression deepened gradually, made a clockwise loop and attained tropical cyclone characteristics by 1600 UTC on the 5th, when it was named Hilda by the Brisbane Tropical Cyclone warning Center (TCWC).

Hilda continued to intensify and moved in an easterly direction until late on the 6th. It attained storm intensity by 2230 UTC on the 5th and reached peak intensity shortly afterward, with maximum average winds

estimated at 55 knots close to the center and gales extending to about 120 miles from the center.

By late on the 6th, Hilda had curved toward the southeast and was accelerating to about 20 to 25 knots. It passed some 120 miles southwest of New Caledonia on the night of the 7th (New Caledonia time), curving towards the south southeast as it did so. By then the system had entered an area of strong upper-level winds and was weakening rapidly as a result of increasing shear. It was finally downgraded to a depression around 1800 UTC on the 7th.

Hilda did not pose any real threat to any country during its entire lifespan, but New Caledonia did experience heavy rain from the system on March 7th. No reports of any damage were received at Nadi.

Tropical Cyclone Rae
March 16–23, 1990

Rajendra Prasad

A shallow depression formed in the South Pacific Convergence Zone, west of Tuvalu, on the 16th of March. The depression passed about 60 miles east of Rotuma on the afternoon of the 18th. It maintained a southerly track for about 24 hours and then started to turn southwestward and slow as it approached Fiji. All this while the system appeared very disorganized, in satellite imagery, with average winds of about 25 to 30 knots in a broad area north and east of the center, which was located about 40 miles west of the Yasawa Group. By late on the 22d, average winds around the depression were estimated to have reached gale force and the system was named Tropical Cyclone Rae.

Rae reached peak intensity on the 23d (around midday Fiji time), with average winds estimated between 45 to 50 knots and gusts to 70 knots, close to the center. It maintained this intensity for about 18 hours before weakening, as a result of shearing from strong upper-level winds.

At this time the system took a sharp easterly turn and began to accelerate. Rae moved into higher latitudes, where it began to encounter increased shearing from strong upper-level winds. This and its entry into a cooler environment, caused the cyclone to lose its tropical characteristics, and it was downgraded to a depression at around 1800 UTC on the 24th. By then the system was located about 650 miles southeast of Niue.

The Fiji Group experienced strong, gusty winds and widespread rain for about 5 days, beginning on the 19th. Rainfall was particularly heavy from the afternoon of the 20th until the 23d, with major flooding in most parts of the Group. For the 24 hours ending at 9 a.m. on 21st March, most of the climatological stations in the country recorded rainfall between 100 millimeters and 250 millimeters with new records set at Monasavu in the interior of Viti Levu, Matei in Taveuni and Viwa island in the Mamanuca Group. The highest fall was at Monasavu with 443 millimeters.

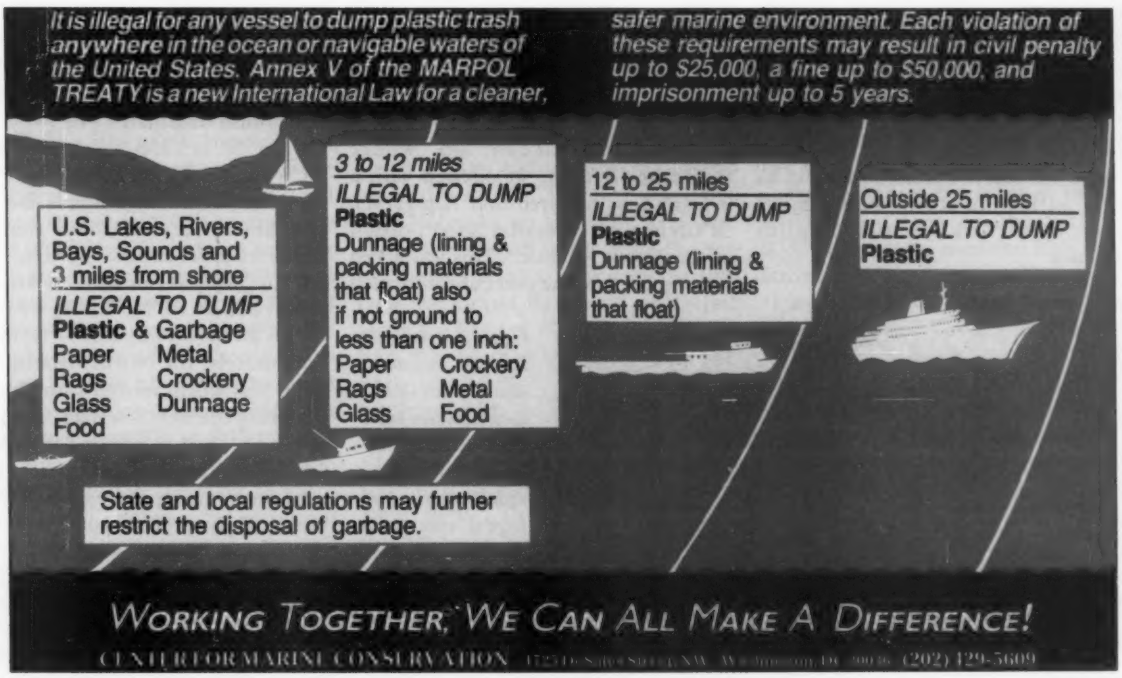
Torrential rains brought flash floods to most parts of the country, causing water levels in rivers and creeks to rise to several meters above normal. At least two main towns of Nadi and Ba suffered major flooding from the nearby rivers. Strong winds and adverse weather conditions affected both air and sea transportation as well. Apart from transportation, disruptions also occurred in the supply of water and electricity. Three deaths were reported by the media, all through drowning in flooded rivers. Wind damage from the system was light, with the uprooting of some trees, and minor damage to houses and crops.

WARNING!

TO ALL MARINERS

As of July 31, 1990 all vessels over 26 feet in length must display anti–dumping placards. This is Federal Law.

Since December 31, 1988 MARPOL Annex V, an international law protecting the marine environment, bans the dumping of plastic trash at sea and places restrictions on disposal of other types of shipboard solid waste. Additional requirements are placed on vessels of 40 feet or more in length. The placards as shown below and additional details are free from the **Center for Marine Conservation**. Just write to the address on the placard.



North Atlantic Weather Log January, February and March 1990

January— A 1028-mb High, centered over the Azores (fig 1), was more reminiscent of July than January, and resulted in positive anomalies over Europe and off the U.S. East Coast. However, the 982-mb Icelandic Low, with its -18 mb anomaly, centered over Iceland was a stark reminder of the reality of this harshest of North Atlantic winters. The steering levels (500 mb) indicated a general flow toward the east northeast so that, in an ideal pattern, a storm would move from New York to the English Channel.

On This Date

January 20, 1978— A paralyzing nor'easter produced a record 21 in. of snow at Boston and 15 to 20 in Rhode Island. Winds along the coast of Connecticut gusted to 70 mph.

Ocean Weather

This month picked up where December left off. It opened with a 975-mb Low centered over Kap Farvel; its circulation covered a good portion of the North Atlantic. This was a red herring because the real culprit formed in December, over the U.S., and made its way into the St. Lawrence Seaway as the month began.

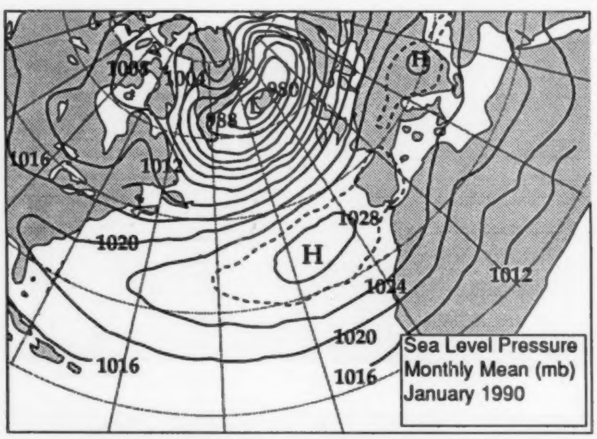


Figure 1.— An Icelandic Low, the likes of which have never been seen before in the history of this publication, combined with a potent Azores High to create a miserable month for North Atlantic mariners.

❶ The power of this storm became immediately apparent on the 2d when the central pressure plummeted to 946 mb from a 984-mb reading the day before. Two large Highs covered the waters south of 40°N, but this horrendous storm dominated everywhere else. On the 3d at 1200, the P3PEZ (48°N, 39°W) was clipped by 58-kn west southwesterlies, while the *Faust*, in the vicinity 6 hr earlier, hit 60-kn southwest winds in 20-ft swells. Earlier, on the 2d, the ***Jokulfell*** ran into 52-kn southeasterlies at 57°N, 35°W, while the CGBK hit 60-kn winds at 47°N, 60°W. Fortunately, for North Atlantic shipping, this storm moved into the Davis St during the next few days. Actually, it appears that a secondary center formed, within the circulation to the northwest, giving the appearance of a move. Meanwhile, another storm from the North Pacific took its place off southern Greenland, giving the appearance of a semi-permanent feature.

This system was detected on the lst off northern California. After a swing through the southwestern U.S. and across the Great Lakes, it entered

the Atlantic, from the St. Lawrence Seaway, as a 984–mb Low on the 5th. It hit the Gulf Stream the following day, and strengthened to 964 mb south of Kap Farvel. The CGHR8 (49°N, 50°W) hit 45–kn southerlies, at 0600, just south of the center; she reported a 993–mb pressure. On the 7th, the 960–mb system moved eastward, but was swallowed up by Storm No. 2.

❷ This system began innocently enough, off Cape Hatteras on the 6th, as a wave along the front of the previous storm. By the 7th, it had its own circulation, and the following day became the dominant center southeast of Kap Farvel. By 1200 on the 8th, the pressure was down to 939 mb. The *Starlight Express*, close to the center at 0600, indicated a 964–mb pressure in 52–kn northerlies. This was confirmed by the ***Contship Europe*** near 46°N, 44°W; from 1500 through 2100 she experienced 52–to 64–kn winds in 7–to 14–ft seas. At 1500, her pressure dropped to 966 mb. On the 8th, an excellent series of reports was received from *OSV C*, south of the center, near 53°N, 39°W. Her winds ranged from 48 to 58 kn in 16–ft seas, over a 7–hr period beginning at 0000. The wind direction started at 320° and gradually backed to 260°, while pressure began at 967 mb and gradually rose to 991 mb as the storm moved away. Some 150 mi southwest of the center, at 0000, the *Sarda* punched in a 70–kn southerly in 20–ft seas. Twelve hours later her wind speed dropped to 54 kn, while her pressure rose from 975 to 1012 mb.

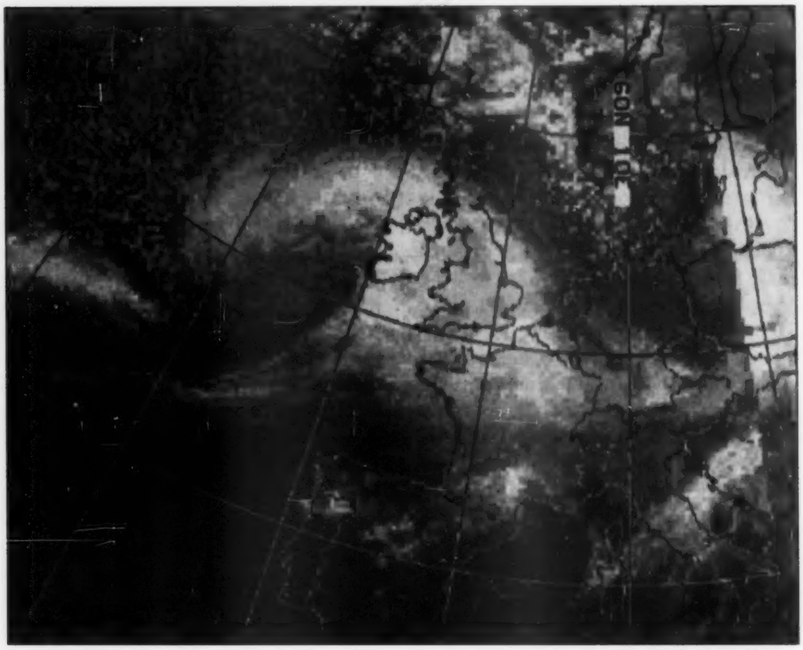
On the 9th, this vicious storm moved through the Denmark St sporting a 956–mb center. The strongest wind reports came from the storm's southeast quadrant, north of 60°N. The *Reykjafoss* (62°N, 10°W) hit 60–kn winds at 0900 and 1200, while the ***Disarfell*** ran into 60–to 68–kn winds from 0300 to 1200. The *Laxfoss* battled 52–kn southwesterlies at 0900 near 63°N, 18°W. On the 8th at 1500, the *Nivi Ittuk*, close to the center, measured a 941.4–mb pressure in 30–ft seas with a slope of about 1/6— very steep and probably breaking. Her winds at the time were westerly at 85 kn. This might be dismissed as erroneous, however, 6 hr later she reported 80–kn westerlies, 30–ft seas, and a 967–mb pressure. This dangerous storm finally began to ease somewhat on the 10th, as it turned eastward along the 70th parallel.

During the next 10 days a parade of low pressure systems moved from the Canadian Maritimes and New England to Iceland and the Denmark St. This resulted in a nearly semi–permanent low over Iceland. These storms were of moderate intensity often generating gales and sometimes storm force winds. Occasionally, several centers would combine and a system would intensify briefly. On the 20th, one of these systems became potent. This marked the beginning of an extremely severe period of weather over the eastern North Atlantic during the last 10 days of January, and set the stage for a horrible February.

❸ Two systems merged, on the 20th, south of Kap Farvel, Greenland and made this storm. The first developed over Nebraska on the 16th, as a wave along a stationary front, while the second system didn't appear until the 19th over the Grand Banks. It developed along the front of the first storm, which had moved into the Labrador Sea. Early on the 20th, its 968–mb center combined with the new center to form a potent 950–mb storm. The ***Abitibi Claiborne*** encountered 60–kn west southwest winds, in 16–ft swells, near 48°N, 34°W. The ***OCCL Challenge*** battled 50–to 60 kn winds from 1200 on the 20th through 0600 on the 21st, reporting every 3 hr. She was rolling in 22–ft swells, during that period. Other vessels reporting storm force winds included the ***Polyasrnyy Zori, Le Brave, William, Wilfred Templeman***, CGCY and *OSV C*. *OSV C*, at 52°N, 36°W, fought 47–to 50–kn winds in 14–to 24–ft seas, from 0700 on the 20th through 0600 on the 21st.

On the 22d, the 966–mb center was just north of Iceland and still causing havoc throughout the North Atlantic. The ***Meerkatze*** (59°N, 42°W) battled winds that ranged from 45 to 62 kn during the day, and the ***Abitibi Claiborne*** ran into a 60–kn southwesterly, near 50°N, 17°W, at 1800. The circulation, which remained centered near Iceland, kept absorbing others or reforming— a true semi–permanent Icelandic Low. At 0000 on the 24th, the 940–mb central pressure generated gales south of 50°N. The GLDF (47°N, 27°W) reported 64–kn winds at 1800, in 22–ft seas, while the ***Canmar Europe*** hit a 58–kn blow near 47°N, 36°W. ***OSV L*** caught 48–kn westerlies in 10–ft seas, most of the day, near 57°N, 20°W. The ***Reykjafoss*** (63°N, 13°W), in 52–kn winds, recorded a 955–mb pressure at 0000 on the 24th. The pounding continued the following day, while another storm was coming to the fore.

❹ This system came to life east of New Jersey on the 21st. Moving east northeastward, it played second fiddle to the Icelandic storm for most of its early existence. Early on the 25th, the 973–mb center crossed the 20th meridian near 51°N. It merged with the system to the north, and roared into England with a 952–mb center by 1200. Wind records across the country were shattered, along with trees, power lines, and windows. Gusts up to 78 kn were recorded in Bristol; at Bradford–on–Avon a local train was derailed due to debris on the line. J.M. Heighes of Sandhurst recorded a westerly gust of 80 kn at 1349 on the 25th. Late in the day, heavy rain spread into southern Ireland turning to sleet over the Midlands and heavy wet snow across County Donegal. By 0600 on the 25th, the 959–mb Low was west of Ireland (fig 2). Three hours later, it moved to



Satellite Data Services Division

Figure 2.— Storm No. 4, centered just west of Ireland early on the 25th, wreaks havoc across the entire British Isles.

near Kintyre, in southwest Scotland, generating gusts of more than 60 kn to the west and south of Erie. Over central Britain gusts reached 100 kn. From Cornwall to Scotland, over the Midlands and northeast England, transport was thrown into chaos; airports and railway stations were closed and roads were blocked by trees. Many London commuters were stranded when all but one of the main railroad stations were forced to close.

More than 80 people died and hundreds were injured by this storm, which lashed Britain and northern Europe; damage was estimated in the hundreds of millions of dollars. Great Britain took the brunt of the storm damage and suffered 45 casualties. The storm lashed Denmark, where, in southern Jutland, seas were whipped up to 9 ft above normal, but the dykes withstood the battering. Dutch meteorologists said the storm was the worst to hit the Netherlands in 10 yr. See the casualty section for more details.

By 1200 on the 26th the 960–mb Low moved across Sweden, where winds ripped roofs off houses and snapped trees. It weakened slowly, but Europe got little rest before the next big blow.

❺ Two systems were responsible for the last big storm of the month to blast Western Europe, which has not been hit this hard since World War II. Both storms formed on the 24th, one in northern Texas and the other over the eastern North Pacific. The Texas Low moved northeastward, and off southern Labrador on the 27th. Meanwhile, the Pacific Low made its way across Canada and moved over Hudson Bay on the 27th. It emerged from the northern Labrador coast on the 29th as a 976–mb Low. By this time, the Texas Low had redeveloped and exploded. At 1200 on the 20th, central pressure read 964–mb; 24 hr later it fell to 957 mb.

The Pacific Low was also intensifying. Between the 29th at 1200 and the 30th at 1200, its pressure plumeted from 981 mb to 953 mb. At the same time, the reformed Texas Low approached northern Scotland sporting a 958–mb pressure, just 5 days after a 952–mb storm had moved across central England. This is comparable to the east coast of Florida, being hit by two severe hurricanes in less than 1 week, with another hovering 300 mi offshore.

In the present case, two of the centers combined into one mammoth system by the 30th. Storm force reports began on the 27th, when the CGBP and BYSM both hit 50–kn winds near 49°N, 62°W. The following day the onslaught began in earnest. The ***Koln Atlantic*** (48°N, 32°W), ***Canadian Explorer*** (48°N, 32°W) and the SGHY (48°N, 39°W) experienced winds in the 60–kn range. By 2100 on the 28th, the ***Koln Atlantic*** encountered a 70–kn westerly in 42–ft seas; this continued into the 29th.

A plot of the ship reports, from the 28th through the end of the month, shows that the area most affected was north of 40°N and east of 50°W. There were few reports between 50° and 55°N but a host of observations between 40° and 50°N. Reports of strong winds on the 30th and 31st were most plentiful east of 30°W, including the North Sea, English Channel and the Skagerrak. ***OSV C*** looked alone on station (51°N, 37°W), but provided a continuous record on the 28th, when her winds ranged from 50 to 60 kn in seas that varied from 15 to 30 ft. Her pressure hit bottom at 957 mb at 1300 that same day. On the 29th, a buoy in the Irish Sea recorded a 67–kn northerly. At 1200 on the 31st, the ELGA5 (58°N, 10°E) was blasted by 58–kn southerlies. The list goes on and on,

but, in general, the storm remained potent into the beginning of February. The casualty section has more details.

Casualties

The ***Irving Forest*** sent a Maday on the 11th when it began taking on water off the Azores; four containers were believed to have been washed overboard. The crew abandoned ship when she listed heavily to starboard. They were rescued by the ***Nestor.*** The Cyprus-registered bulk carrier ***Charlie,*** 20,246 tons, with a complement of 27, including the Chief Engineer's wife, was last reported in violent weather, on the 20th, some 400 mi west of Newfoundland. Winds in the area were storm force 11 and waves were 30 ft.

During the storm that hit England on the 25th, there were many marine incidents. Both the ***Rio Santa Rosa*** and the ***Funchal Pass*** lost propellers resulting in damage to deck and hull. The ***River Asab*** in high winds at Antwerp, suffered contact damage; the ***Auto Atlas*** reported heavy weather damage on the 20th. The passenger ferry ***Brightlingsea*** suffered damaged on the 25th as did the Mv ***Sea Mother.*** The Mv ***Jotun*** capsized on the 26th in the Baltic Sea, and the ***Briz*** ran into trouble the same day; all 56 of her crewmen were rescued. The 60-ft harbor tug ***Impulsion*** with three people aboard capsized in force 9 to 10 winds in the North Sea; they were rescued by the Lowestoft pilot boat. The ***White Stone, Cottic Navigator*** and ***Faust*** all ran into trouble on the 25th. The barge ***Cursham No 18936,*** in tow, in Gravesend Reach sank, with 29 loaded refuse containers, on the 25th. The ***La Fayette,*** with five seamen, was missing after reporting smashed portholes off the coast of Brittany on the 25th. The ***Reefer Star*** encountered hurricane force winds on the 25th and 26th with resulting hatch cover damage and flooding. The Mv ***Zorro*** sank on the 25th at Antwerp.

Hurricane winds tore across the flat lowlands of Holland on the 25th, leaving several dead and hundreds injured. West Germany suffered extensive damage to buildings and parts of the Hamburg Harbor were flooded; at least five people were killed. France suffered at least eight deaths, as the storm generated 94-kn gusts across the northern reaches of Brittany. Three fishermen were listed as missing after their catamaran sloop ***Revolution*** overturned while being towed. In Belgium, 10 people died and dozens were injured, mainly by falling debris and uprooted trees; winds gusted to 55 kn.

During the last storm of the month, the ***Flag Theofano*** sank on the 30th off the Isle of Wight. A woman who witnessed the sinking did not call the lifeboat, because she thought help was on the way. She saw flares after the boat, which was pitching and rolling in heavy seas, vanished and assumed someone else had alerted the emergency services, but the lifeboat was on another mission. Nineteen lives were lost. The Mv ***Inisher*** heading for Belfast Lough, in rough seas and winds gusting to 50 kn, lost a container overboard as cargo shifted.

February— An unbelievable winter continued in the North Atlantic this month. While December and January were much more severe than normal, they were merely a prelude to a February climax. It is easy to get carried away with adjectives, but it is safe to say there has probably never been a month quite like this one. A look at the pressure chart (fig 3) shows the Icelandic Low at 976 mb. In terms of a single storm that's a moderate winter system. In terms of a climatic feature it's almost beyond belief. The incredible negative 16-mb anomalies of December and January pale beside the negative 36-mb anomalies of February.

The greatest departures were between Iceland and Ireland, where all of the great storms of February passed. A look at the 500-mb level confirms this pattern with a nearly zonal flow from eastern North America to 45°W, and then a bending toward the northeast. This, in real time, would tend to take a storm from New York and steer it into the English Channel, while a Newfoundland storm would end up over Scotland in an ideal situation.

On This Date

February 17, 1958— The greatest snowstorm of the mid 20th century struck the northeastern U.S. The storm produced 30 in of snow in interior New

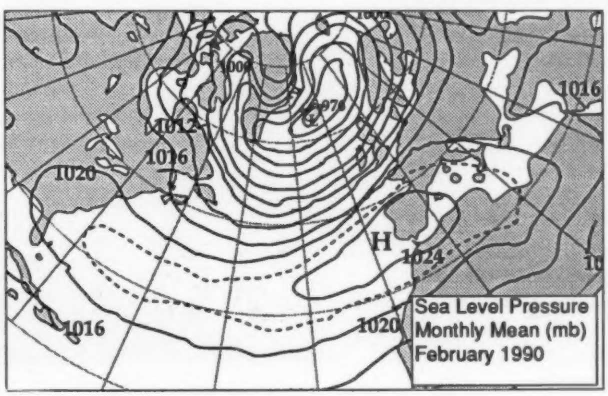


Figure 3.— The winter of discontent for everyone who plied the North Atlantic continued in February, and was well represented by an incredible Icelandic Low.

The Bent–Back Warm Front

G.A. Monk

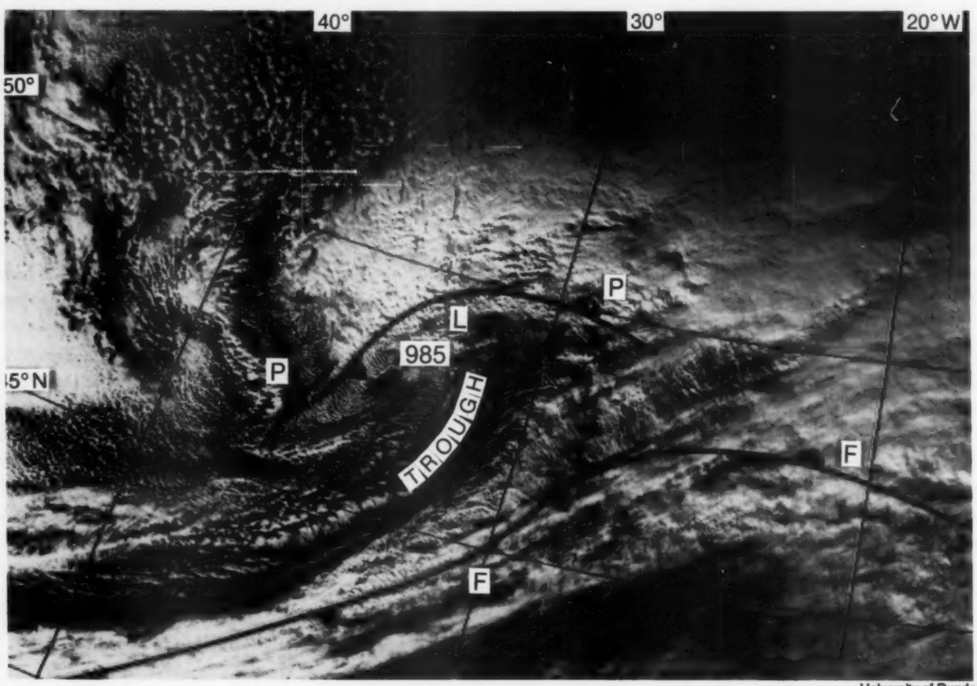
This short but important piece appeared in the April 1990 Meteorological Magazine, of the Meteorological Office of Great Britain. We are indebted to them for the use of the article and photographs.

The photographs were taken at approximately 12–hour intervals during cyclogenesis of the storm that caused extensive wind damage and loss of life over southern Britain on January 25, 1990. The locations of the superimposed synoptic features are based on evidence derived from imagery and conventional surface data (interpolated where necessary using data from main synoptic hours).

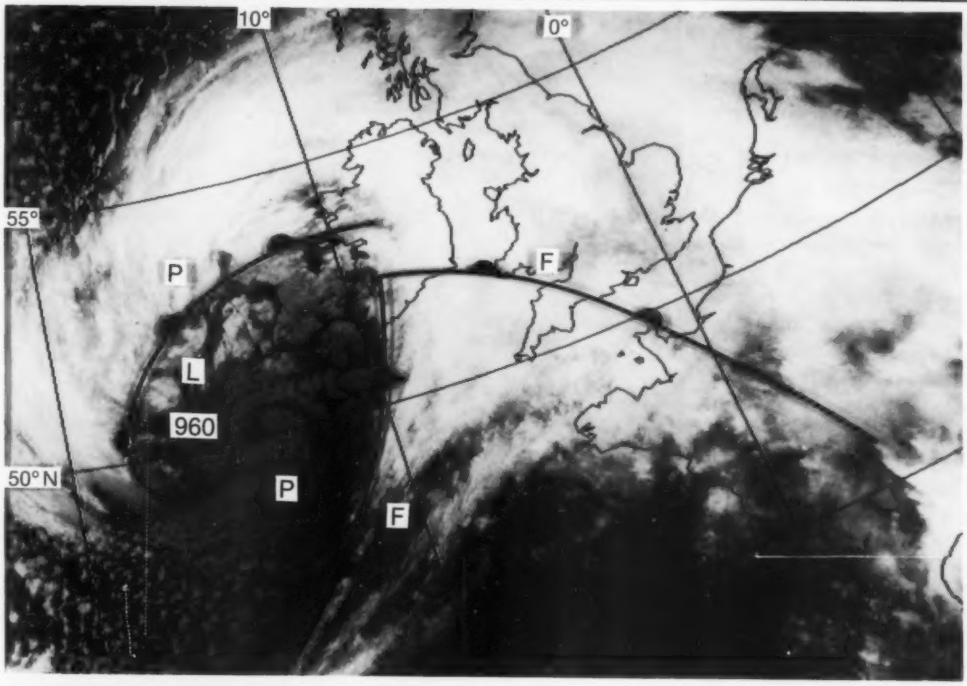
The cloud pattern on the NOAA–11 visible image, at 1515 UTC on January 24, 1990 (below), suggests two distinct frontal zones— F associated with the main jet stream and P being a secondary frontal zone forming in the cold air mass. The overall cloud area, encompassing clouds associated with both fronts, constitutes a *cloud head* characteristic of impending explosive cyclogenesis and generation of hurricane force winds.

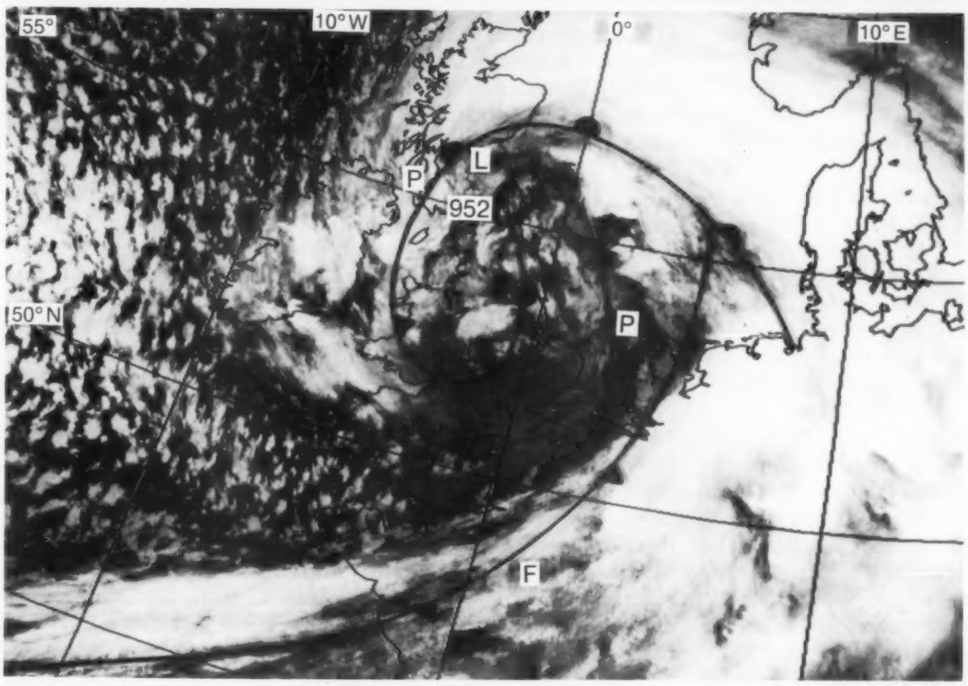
During subsequent cyclogenesis (page 55; upper photo, NOAA–11 infra-red at 0330 UTC on the 25th and lower photo, NOAA–11 infra-red at 1325 UTC on the 25th) the wave in front F gradually sharpens, but the part of the front P behind the low accelerates around the right flank of the low so as to leave a core of warm air near its center. This also occurred during the development of the October storm of 1987, and in each of the intense depressions that crossed southern and central Britain during the stormy period of January and February 1990. The most active front (in terms of thermal contrast) was always the *bent–back* warm front (not an occlusion) around the left flank of the low, and the strongest winds (stippled area in chart on page 56) always occurred at and behind the secondary cold front P in an area bounded by the *bent–back* front.

The frontal analyses shown here are consistent with thermal fields derived from the UK fine–mesh model. The warm core and *bent–back* front are clearly evident in the 850 mb wet–bulb potential field shown in the chart on page 56. In this chart the surface isobars and isopleths of 850–mb wet–bulb potential temperature (°C, in dashed lines) are from the 1200 UTC analysis of the fine–mesh model,; the region of strongest winds (stipled area) are at 1300 UTC.

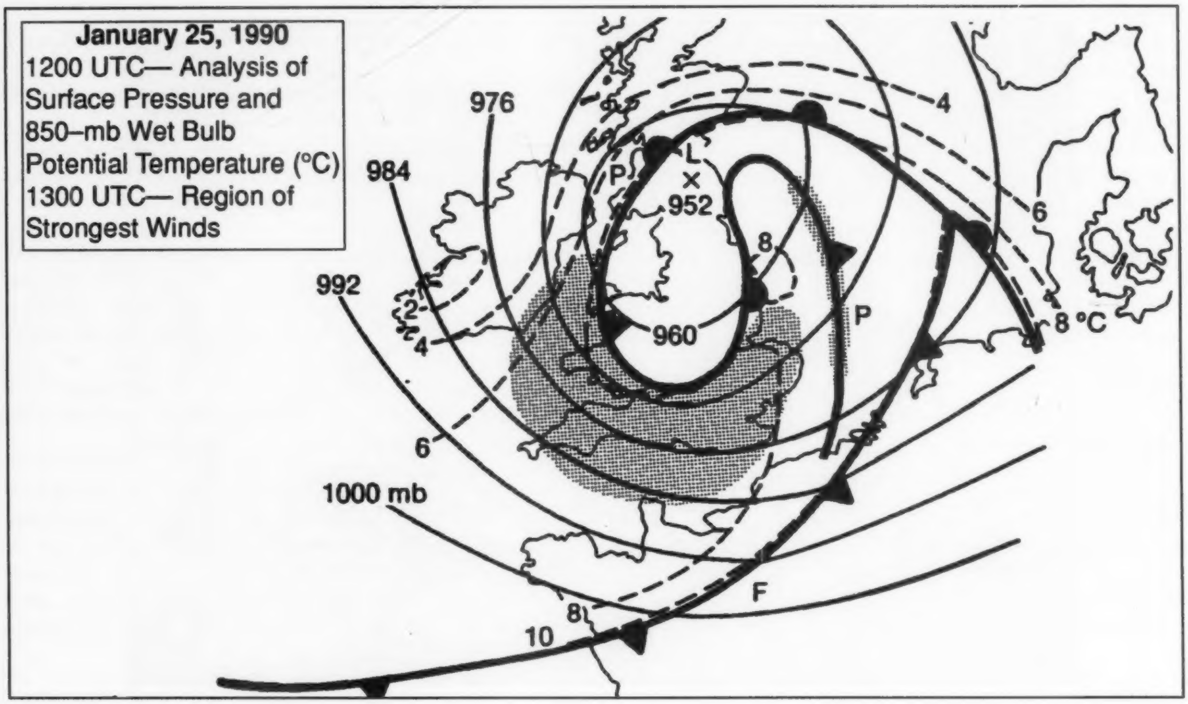


University of Dundee





University of Dundee



England, and more than 19 in. in 24 hr fell at the Boston Airport.

Ocean Weather

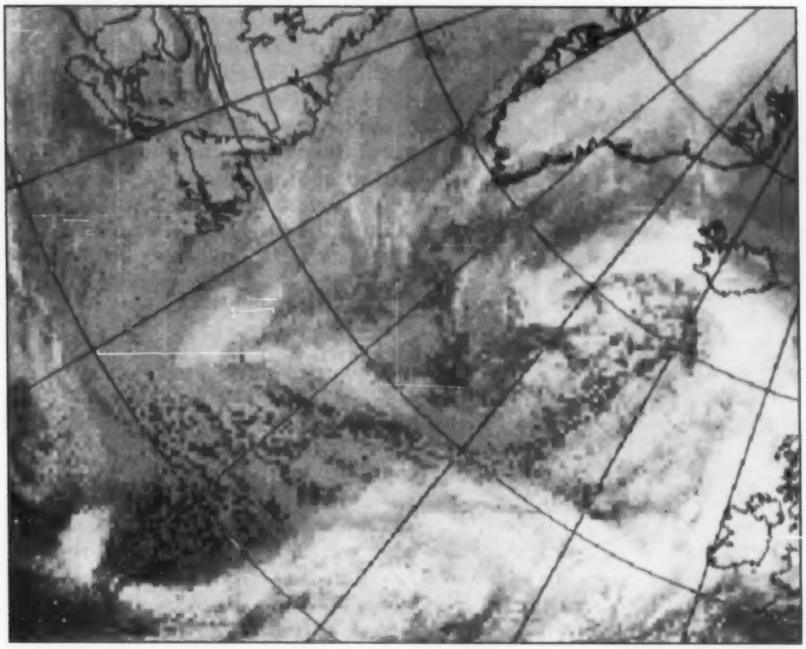
The powerful storms of February were spawned in such diverse locations, as Oregon, Lake Michigan, Louisiana, Connecticut and Vermont. All ended up passing between Iceland and Ireland, resulting in a devastating month for shipping and coastal concerns in the northern North Atlantic.

❶ This storm spawned in Louisiana toward the end of January. It came to life, on the 29th, as an atmospheric wave along a stationary front that covered the southeastern U.S. It rode this front northeastward; by the 30th at 1200 it had a definite 990–mb circulation just north of Cape Cod, MA. However, it was soon forced eastward by the huge storm that was presently devastating Europe and the eastern North Atlantic. By 1200 on the 31st, Storm No. 1 began to fill. However, while the month was ending, the storm wasn't. On the 1st of February, it quickly reintensified, and swung northeastward, after crossing 20°W. By 1200 it was suddenly a potent 960–mb system, as it merged with the center to the north. The circulation soon covered the entire eastern North Atlantic, north of 40°N. To the south were several large high pressure centers, with pressures ranging from 1024 to 1029 mb.

Reports of 50–to 55–kn winds came in from as far south as Lisbon. Swells were running up to 30 ft, and there was even a report of a 50–ft swell by the ***Ludwigshafen Express***. Ships reporting in included the ***Heemskerck, Euro Mexico, Norgass Discoverer, Tineke, Professor Marti, Canmar Ambassador, Atlantic Compass*** and the ***America Express***.

The center, off Ireland on the 1st, was pounding Great Britain. The following day it moved through the Faroe Is as a 958–mb storm. Gale and storm force winds racked the Norwegian and North Seas. Wind gusts up to 90 kn occurred in the Ile de France region of France. The ***Sulisker*** recorded a 966–mb pressure, near 58.9°N, 3.7°W, at 1200 on the 2d. At 1800, the ***Drupa*** ran into 58–kn south southeasterlies near 60.7°N, 4.2°E. Seas built to 26 ft. The battle continued for the next few days. The system continued northward, only to be replaced by an even stronger storm.

❷ This storm can be traced back to Lake Michigan on the 1st. It emerged from the St. Lawrence Seaway the following day, as a 980–mb Low, on an east northeastward heading. It began to intensify rapidly. From 980 mb, at



Satellite Data Services Division

Figure 4.— This infra-red satellite photo was taken in the early morning hours of the 4th. With its associated frontal systems, the Low dominated the shipping lanes.

1200 on the 2d, it fell to 958 mb by 0000 on the 3d and dipped to 944 mb 24 hr later (fig 4). By this time, it was turning northeastward after crossing the 30th meridian. Its circulation covered the shipping lanes from the Grand Banks to Western Europe. For example, the ***Wilfred Templeman*** encountered 40-kn northwesterlies off Cape Race, while the ***Pinro*** was nailed by 43-kn southerlies off Trondheim, Norway. Closer to the center, conditions were not quite so rosy. The ELFLB (52°N, 31°W) spotted a 60-kn southwesterly, in 23-ft seas and recorded a 954-mb pressure. At this time, most of the storm force winds (50 kn or more) were south through west southwest of the center. The highest swells were running 20 to 33 ft from the southwest through west.

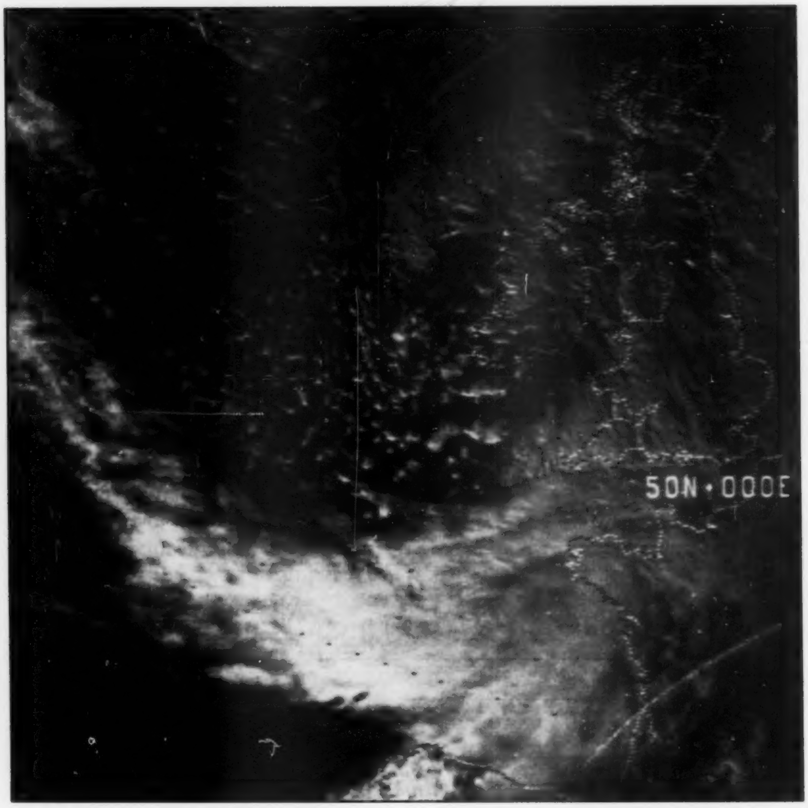
At 1800 on the 4th, no less than eight vessels reported storm force winds, mainly south and southeast of the center. The ***Contship Egypt***, nearly 800 mi southeast of the center, ran into a 64-kn south southwesterly in 40-ft swells. The following day the storm moved across Iceland sporting a 954-mb center. Winds in the North Sea winds were running 40 to 55 kn. East and west of the Azores conditions were similar, as a cold front whipped through the area.

By 1200 on the 5th, a 988-mb Low had moved off the mid Atlantic Coast of the U.S. and crossed the 40th parallel along 60°W. However, unlike its predecessors, it did not become an intense storm. Storm No. 2, meanwhile, continued northeastward and out of harm's way by the 6th.

Conditions became quite complex across the North Atlantic during the next several days; relatively small highs and lows covered the ocean north of 30°N. By the 11th, a large 1040-mb High centered itself near 37°N, 30°W, after a week-long journey from Texas. A 945-mb Low intensified southeast of Iceland. The pressure gradient between the two created weather problems over the eastern North Atlantic.

❸ This storm can be traced back to northeastern British Columbia on the 5th. It moved eastward, along the 55th parallel, for a couple of days, and then on the 7th, after crossing James Bay, it dipped to the east southeast. It came out of the Gulf of St. Lawrence, as a relatively weak system, on the 8th. The following day there were two stronger centers to the north. Eventually Storm No. 3 inherited their circulations; by 1200 on the the 10th, the central pressure was down to 967 mb. Some 24 hr later it dipped to 945 mb and the storm was dominating the eastern shipping lanes (fig 5). At 0000 on the 11th, the ***McKinney Maersk*** (59N, 12°W) and the P3IY3 (60°N, 17°W) were belted by 60-kn westerlies. The former ran into 30-ft seas. The latter recorded a 964-mb pressure, which dropped to 962 mb 3hr later, as her winds increased to 68 kn. In general, winds ran 40 to 60 kn. The VTEQ (48°N, 18°W) at 1200 encountered 36-ft seas in 60-kn westerlies. By 1800 on the 11th, the ***Theodor Storm, Professor Marti, Bastiaan Broere, Cast Husky***, and ***Sloman Runner*** all picked up winds of 60 kn or more, from near Brest west to about 20°W. Swells in the area ran 35 to 45 ft, with a long fetch set up from the northwest. The storm remained potent until about the 14th. At thi. time, the most outstanding features on the charts were two large Highs, one off the mid Atlantic coast of the U.S. and the other off Portugal.

These relatively placid conditions were interrupted, first on the 16th by a system that intensified briefly into a 962-mb Low, along the southern Greenland coast, and then on the 18th when a 965-mb Low burst upon the



Satellite Data Services Division

Figure 5.— Early on the afternoon of the 11th, satellite imagery shows a 960–mb center over Ireland, while a second more powerful center off Iceland is not so easily recognized.

scene near 50°N, 30°W.

❹ This system came to life, in the moonlight of Vermont, on the 16th. It moved rapidly eastward; by 1200 on the 17th it was a 997–mb Low near 43°N, 41°W. In 24 hr it turned northward and deepened to 965 mb— a drop of 32 mb. By the 19th at 1200 (fig 6), central pressure dropped to 941 mb, as the system moved between Iceland and Ireland. This complex system, with another center off southern Greenland, dominated the North Atlantic north of 45°N in the west and north of 35°N in the east. At 1200, the ***Sea–Land Integrity, Norna, Seaboard Invincible Kuzma Minin, Atlantic Amity, Drupa,Reykjafoss, Arfell,*** LAF14, GBXW, DBFJ, LFAW, LF3J and the 6CDF all reported storm force winds. Seas ran 13 to 26 ft; the P3HZ2 recorded a 954–mb pressure. Two of the vessels were caught in a pressure gradient squeeze, near 40°N, 40°W, while the others were in the northern North Sea and Norwegian Sea. Even at 1200 on the 20th, after crossing the 70th parallel, the storm still possessed a 942–mb pressure center. Although this storm had the lowest pressure of the month it was Storm No. 6 that became the monster among monsters.

❺ This system began innocently enough along the Oregon–Idaho border on the 17th. The following day it crossed into Canada, where it swung through James Bay on the 19th. The 996–mb Low with a cold front, which swept across the eastern U.S., dipped southeastward, and came out of the Gulf of St. Lawrence like many of this month's potent storms. At 1200 on the 20th, its 984–mb center passed off Cape Race. During the next 24 hr, the central pressure plummeted to 956 mb, as the system began a swing to the northeast. Because it was flanked by a large 1035–mb High, over the Mediterranean, a very tight pressure gradient developed across the British Isles and northern Europe. At 0000 on the 21st, the action was mostly from 40° to 50° N between 35° and 45° W, where the ***Karl Libknekht, Cryos, Daynava,*** and the ***Kapitan Nokhrin*** experienced winds in the 50–to 58–kn range, with 10–to 20–ft seas. Conditions persisted during the day, although the bad weather box stretched to 50°N and 15°W by late on the 21st. In some encounters, swells reached 40 to 50 ft southwest of the center, where a long fetch from the northwest was evident.

Satellite Data Services Division

Figure 6.— This potent circulation is centered between Iceland and Ireland around midday on the 19th.

As quickly as the storm intensified it fizzled. By 1200 on the 22d, it filled to 970 mb, and continued to weaken as it passed east of Iceland the following day.

❻ Monster of the Month— A very complex system was responsible for some of the worst weather of the month. The storm, or combination of storms, began to take shape on about the 24th. At this time, a 974–mb Low was analyzed just east of Kap Farvel, Greenland. In addition, a 994–mb center was detected near 55°N, 10°W, and a 990–mb Low was spotted off Cape Cod. A large 1038–mb High dominated a good portion of the North Atlantic south of 45°N. The system off Cape Cod fizzled, and the one off Ireland scooted rapidly northeastward during the next 2 days. The Greenland Low moved east northeastward within a broad low pressure area, which encompassed the North Atlantic, north of about 45°N, and included several other centers. By 0000 on the 26th, three separate centers were identified— two at 959 mb and the Greenland center at 957 mb. In addition, the High to the south built to 1046 mb tightening the gradient across the northern shipping lanes. The eastern North Atlantic, including the waters from the Norwegian Sea to the Bay of Biscay, was being pounded. At 0000 on the 26th, vessels reported 40–to 50–kn winds, and a few, like the ***William*** and the ***Professor Marti***, came in with 60–kn readings. By 1200, winds of 50 kn and more were common from the Bay of Biscay, through the English Channel, to the North Sea. A few storm reports came in from west of Ireland and north Iceland. Seas ran up to 30 ft, particularly at the western approaches to the English Channel. Some of the vessels reporting included the ***Bergen, Maloja II, Rover, Yulin, Tambov, Hekeabe, Maersk Dispatcher*** and the ELMSS.

Wide World

Figure 7.— English Channel waves break violently against the promenade, while two cars are pass by, in the Brittany sea–front town of St. Malo on the 28th. The storms lasted most of the week and claimed dozens of victims.

Several ships reported pressures around 956 mb. The lowest was a 953.7 mb, in the North Sea, from the ***Maersk Dispatcher.*** At this time, a center was analyzed near 59°N, 5°E.

Along the coasts of Great Britain, East and West Germany, France, Denmark, and the Netherlands, strong winds and high tides caused severe damage (fig 7). Along the Dutch coast, water levels were at their highest since 1953. In northern Wales, tides smashed a 600–yd hole in the seawall at Towyn. Between Folkestone and Hythe (England), houses flooded when a broken seawall let in mountainous waves. High tides brought extensive flooding to the south coast England. Worthing and Hastings, in Sussex, and Cowes, on the Isle of Wight, were badly damaged. Wind gusts exceeded 70 kn in France, 80 kn in Germany and 85 kn in Britain. See the casualty section for more details.

The Norwegian center remained intense as it moved across Norway, Sweden and Finland from the 26th through the 28th (fig 8). Even at 0000 on the 28th, the central pressure still read 947 mb; the system was less of a threat to shipping as it continued inland.

Casualties

From Storm No. 1, the port of Sainte Nazaire, at the mouth of the Loire River, suffered extensive damage to the general cargo and container terminals. Nearby, at Nantes, the suction hopper-dredger ***Atlantique*** was blown aground. Nantes itself suffered extensive damage. Ashore, 23 people were killed in France and another 7 in West Germany during the storms. Many victims were killed when trees crushed their cars.

Cathedrals, Castles and Chapels from Brittany to Champagne reported extensive damage. This included the grounds of the Palace of Versailles, where statues lay smashed alongside uprooted giant oaks. At the Grand Trianon Palace, slabs of zinc weighing more than 650 lb were blown off the roof, while gaping holes could be seen between the spires of the 13th Century Charter Cathedral. The death toll in France was the highest in 20 yr, and damage was estimated at $700 million. In the Scottish highlands, a landslide blocked a main highway; much of the country was hit by gales and floods.

Northeast of the Dutch island of Terschelling, early on the 3d, the ***Mataram*** and ***Theoskepast II*** collided. Since the latter vessel was in danger of sinking, the 10–man crew climbed into a lifeboat and were picked up. The vessel was eventually towed to Delfzyl. The ***Renate G.*** suffered hull damage in heavy weather on the 2d.

On the 6th, the Shell–owned bulk carrier ***Tribulus*** began taking on water after a gash developed in her side during gales. She was some 350 mi southwest of Land's End (Cornwall). Seven of the crew and three officers' wives were airlifted from the vessel, but 15 crewmen stayed aboard to see the ***Tribulus*** into Bantry Bay, where gales proceeded to more than double the size of the hole. The ***Neptunian*** suffered heavy weather damage while enroute from Rouen to Naples during the 8th through 11th. The ***Manitoba,*** enroute to Le Harve, reported heavy weather damage between the 6th and 8th, while the ro–ro ferry ***St. Nicholas,*** from Harwich to the Hook of Holland, suffered heavy weather damage on the 7th.

During Storm No. 3, the following vessels reported heavy weather damage between the 10th and 13th: ***World Prince, Mr West, Hitachi Ventury, IBN Al–Atheer, Radnoti, Palyxeni, Banglar Gourab and the Tara Trader.*** On the 11th, the trawler ***Misto*** with a crew of 16 was limping toward Ireland in gales; the crewmen were rescued, some 28 mi northeast of Eagle Rock. The cement carrier ***Scantrader*** sank in the Bay of Biscay on the 12th, with a crew of 12. Two empty liferafts were found. The new ferry ***Railship III,*** in a German bay 30 mi west of Helgoland, heeled badly after a maneuver in gales on the 12th, resulting in two deaths and fifteen injuries. The ***Palmah II*** lost six containers overboard in the Ushant area, off the tip of Brittany, as she made for Cherbourg. In the same area, the ***Arctic C*** on the 12th, carrying 2,436 tons of cheese, sustained steering gear damage in severe gales. The ***Gilbert Rowe*** a self propelled, self elevating drilling platform broke loose from tugs south of Rotterdam. The 33–man crew was safely evacuated before the platform was driven aground. The ***Didos*** lost 17 containers overboard off Ushant. At Brest, wind gusts knocked over one 150–ft crane and damaged three others.

During the last storm of the month, some 45 people lost their lives throughout Europe, and the shipping incidents were horrendous. Helicopters rescued people from flooded houses in North Wales, where the tidal surge was the highest in 30 yr; it breached sea walls. In Normandy, winds reached 85 kn and flooding was prevalent. Off Brittany, the ***Abu Egila*** lost 8 tons of chemical products. Along the west coast of Denmark, a father and son drowned when their fishing boat capsized. Hamburg, West Germany reported 10 thousand trees uprooted, and the port was closed for several hours. The ***Ming Glory,*** bound for Hamburg, lost many containers overboard near Ushant on the 26th. These containers were filled with TV sets and sneakers. On the morning of the 26th, the ***Danielle*** reported machinery damage, some 66 mi southwest of Penmarch, in wind gusts of 60 kn and seas greater than 18 ft. The ***Maria H*** suffered heavy weather damage on a voyage from Sarpsborg to Rotterdam during the 26th and 27th. The

Wide World

Figure 8.—The walls and roof of a 15th Century house collapsed in Damme, near Burges, Belgium on the 26th, as gales swept through Belgium and other sections of Western Europe.

Anneliese was abandoned by its crew of six, after the bridge collapsed in heavy weather in the Dutch sector of the North Sea. An oil platform crew had to be evacuated, after the vessel nearly drifted into the platform. On the 27th, the Belgian inland waterways vessel *Merrimac*, 610–ft long and loaded with salt, sank at Antwerp, when a harbor crane was blown off quayside onto the vessel in force 7 winds.

March— In a well-deserved turn of events, pressure over the British Isles and western Europe was higher than normal by about 6 to 12 mb. The Icelandic Low, normally centered south of Greenland, was centered in its secondary location off northern Norway (fig 9). The 500–mb flow was oriented east northeastward from North America to 45°W, where it turned northeastward. In general, this indicates storms from the Grand Banks will end up in the Norwegian Sea.

On This Date

March 12, 1888— A blizzard paralyzed southwestern New England and southeastern New York State. The storm produced 58 in. of snow at Saratoga, NY, and 50 in. at Middletown, CT. Record cold, which followed in the storm's wake, along with the snow, resulted in 400 deaths.

Ocean Weather

The month opened with the last potent February storm still causing havoc across Northern Europe. Over the

eastern North Atlantic, conditions became a little more placid as a 1038-mb High dominated the weather — a welcome relief to both shipping and western Europe. Another high pressure area covered the mid Atlantic States in the U.S., and a 974-mb Low moved into the Labrador Sea. The two Highs built as they moved eastward and continued to dominate the weather across most of the Atlantic. A Low formed just east of Kap Farvel on the 2d; the following day, it found the Denmark St. The gradient between it and the Highs generated some strong winds across the northern shipping lanes. South of Iceland at 0600, the V2GP, TFLZ, and DBFJ reported winds in the 40-to 50-kn range; the DBFJ hit 26-ft seas. The cold front, out ahead of the system, was also generating gales in the North and Norwegian Seas. Ahead of the front, seas ran 25 to 35 ft. Winds continued in the 40-to 50-kn range, through the 5th, as the storm moved toward the Barents Sea.

Once again, on the 6th, a large High over James Bay and another centered over the Azores dominated the weather charts. A 986-mb Low southeast of Greenland was making its presence felt over the shipping lanes.

❶ This system actually developed south of Newfoundland on the 4th. However, it wasn't until the 6th that it began to look like a real storm. At 1200, the 986-mb center was near 60°N, 32°W. Twenty-four hours later, it was generating 40-to 50-kn winds in the North and Norwegian Seas. The XPYM (62°N, 6°W) hit 52-kn west northwest winds and measured a 978-mb pressure. The ***Seaboard Invincible***, at 1800, was blasted by a 54-kn westerly, about 100 mi west of Bergen. At 0000 on the 8th, her winds climbed to 60 kn; this was supported by a 52-kn report from the ***Yemelyen Pugachev***, and a 58-kn westerly experienced by the ***Purga***. Seas in the Norwegian Sea were running 16 to 30 ft. Later in the day, conditions began to ease as the storm started to fill. Its front, which trailed southward into the Bay of Biscay, and then westward, triggered another system.

❷ This wave was first spotted on the 6th as Storm No. 1 began to wind up. It was hardly noticeable except for several ship reports, which indicated some evidence of a circulation. By 1200 on the 8th, it developed into a moderate 980-mb Low, as its center crossed the 40th parallel near 50°W.

The ICBA (43°N, 47°W) reported a 50-kn easterly and a 986-mb pressure, while the ***SEDCO 710*** (46°N, 49°W) hit a 42-kn northerly. Six hours later, some 180 mi north northwest of the center, a 58-kn northeasterly belted the ***Viktor Lyagin*** in 20-ft seas. The storm's central pressure dipped to 971 mb, on the 9th, as it headed northeastward. By 0000 on the 10th, it was down to 962 mb. It filled slightly, while accelerating, southeast of Iceland. However, by the 11th, storm force winds battered the North Sea and the southern Norwegian Sea. At 1200 on the 11th, the ***Sulisker*** (58°N, 3°W) reported a 52-kn west southwesterly, while, a short distance away, the ***Norna*** hit 50-kn winds. Seas ran up to 25 ft. Gale and storm force winds continued the following day, but, by the 13th, conditions improved. However a double-barreled system was coming to life to the southwest.

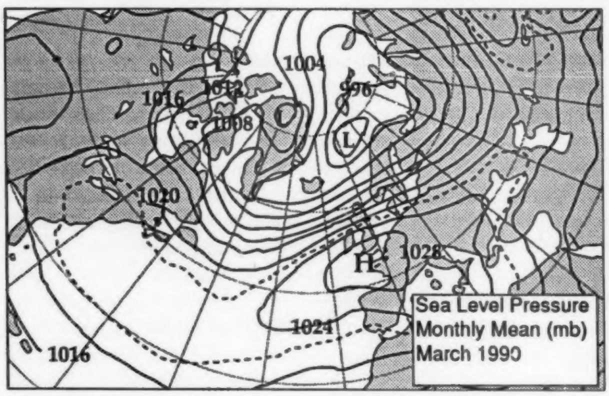


Figure 9.— While the Icelandic Low was displaced to the northeast, Europe got a break as indicated by the large Azores High over the English Channel.

❸ These two storms formed 5 days and about 1300 mi apart. By the 13th, they were within 800 mi of each other, and creating problems for shipping. One developed on the 7th, near 28°N, 62°W, while the other came to life over the Grand Banks 5 days later. By this time, the first system was approaching 55°N, near 30°W, as a 987-mb Low. At 1200 on the 13th, it measured 986 mb while the Grand Banks center dipped to 971 mb. Several vessels, including the GXUB, JBKL, ZCZC and the UFGH, encountered 40-to 45-kn winds in 12-to 20-ft seas. The following day, once again, reports of gale and storm force winds plagued the Norwegian Sea. Seas of 15 to 25 ft made conditions even worse. By 1200 on the 15th, the Grand Bank's center (976 mb) was stalling east of Kap Farvel, while the first center dropped to 967 mb, north of 70°N. The Norwegian Sea continued to suffer, although conditions began to improve the following day.

By the 19th, however, the Grand Banks Low finally moved to the east of Iceland, while a 970-mb storm was developing rapidly, northeast of Labrador.

❹ This system developed on the 18th, along the coast of Labrador. Its central pressure dropped from 991 mb at 1200 on the 18th, to 970 mb 24 hr later. An estimated 953-mb center crossed the 60th parallel, near 30°W, by 1200 on

Satellite Data Services Division

Figure 10.— The NOAA-11 satellite on the 23d of March provides a glimpse of the storm, centered south of Iceland, between 1400 and 1500 UTC.

the 20th. Twelve hours earlier, ***OSV C*** reported 43–kn west southwesterlies, in 23–ft seas, about 300 mi south of the center. At 0900 the ***Grundarfoss*** (64°N, 21°W) ran into 52–kn easterlies, and measured a 976–mb pressure. The ***Nuka Ittuk*** sent in two very extreme, but complete observations; at 0900, near 57.2°N, 32.5°W, she measured a 962–mb pressure, 80–kn southwest winds, and estimated seas at 42 ft. Her 1200 observation of 70–kn west southwesterlies in 39–ft seas, followed; again the pressure was 962 mb. By 1800, her winds dropped to 52 kn and seas to 24 ft, as pressure rose to 978 mb. On the 21st, the storm moved across Iceland and began to fill. However, another potent storm was following in its wake.

❺ This system traveled from Texas, through Ohio, to southern Maryland, before moving into the Atlantic on the 20th. It turned northeastward and began to intensify. By the 22d at 1200, its pressure fell to 985 mb; 24 hr later it was down to 962 mb (fig 10). Once again, the Norwegian Sea was feeling the brunt of a storm. In the Atlantic, at 0000 on the 23d, ***OSV C*** (53°N, 36°W) reported 48–kn southwesterlies in 30–ft swells. Four hours later, her winds jumped to 52 kn. In the Norwegian Sea, winds hit 40 to 45 kn. By 1200 on the 23d, the GBXW, ***Tambov*** and ***Aleksandr Suvorov*** were encountering 50–to 55–kn winds in the Norwegian Sea. Swells of 33 ft clobbered the ***Esso Fife***, near 57°N, 7°W, while the ***Discovery*** (53°N, 18°W) estimated them at 36 ft. The ***Vigilant*** ran into 55–kn south southwest winds, near 58°N, 6°W, at 1800— the same time the ***Sealion Columbia*** (61°N, 1°E) reported a 958–mb pressure. On the 24th, the worst conditions occurred from 55°N to 65°N, between 10°W and about 3°E. Winds blew at about 45 to 55 kn over seas that ranged from 10 to 30 ft. The GJQV (61°N, 2°E) picked up a 60–kn westerly at 0600, and measured a 975–mb pressure while battling 23–ft swells. Nearby, the ***Toisa Sentinel*** hit 54–kn southwest winds, and measured a 972–mb pressure, in 33–ft seas. The storm's 966–mb central pressure was based on a host of ship reports near the center. By the 25th, the storm weakened as it moved across Norway, Sweden and Finland.

In the meantime, a 1050–mb High pushed over the eastern North Atlantic for several days. A Low developed in the Denmark St and briefly intensified to 966 mb, at 1200 on the 26th, but it scooted rapidly northward. The next several days saw a few other transitory systems, but, in general, March, which came in like a lion, went out like a lamb.

Casualties

On the 1st of March, the ***Pacific Countess***, off Port Said, drifted into another vessel, at night, in bad weather conditions. The Mv ***Elly*** suffered heavy weather damage sometime between the 3d and the 5th, evidently, in the Mediterranean, where several ports had to close. Malaga Province, in Spain, suffered extensive coastal damage, as winds reached 68 kn. At Trieste, on the 27th, 75–kn winds caused a container crane to break free and hit the superstructure of the container vessel ***Mont Blanc Maru***.

North Pacific Weather Log January, February and March 1990

January— The North Pacific subtropical high lay farther north, and was more extensive than usual (fig 1). This resulted in positive anomalies of up to 12 mb covering a good portion of the ocean south of 50°N. The Aleutian Low was near or slightly below normal over the Bering Sea. In the upper atmosphere, the flow was nearly zonal (along the parallels) to the dateline, and then curved toward the east northeast. In this idealized pattern a storm off Tokyo might end up over Oregon.

On This Date

January 15, 1971— The extratropical portion of former tropical storm Sarah, from the western North Pacific, passed north of Hawaii. Its strong southwest winds caused over $100,000 damage on Oahu alone. Kaena Pt recorded peak gusts of 60 kn. The ***Susquehanna*** encountered 30-ft swells and 55-kn south southwesterlies, at 0600, on the 16th near 36°N, 42°W.

Ocean Weather

The month opened with a 968-mb Low in the Bering Sea; a 976-mb secondary center formed to the southeast. Soon several other centers became apparent as this semi-permanent system covered a good portion of the northern shipping lanes. A Low that had formed east of Taiwan was headed northeastward and intensified. By 1200 on the 5th it was a 964-mb storm, centered near 45°N and the dateline. A 974-mb Low roamed the Gulf of Alaska at this time.

❶ This system started near 25°N, 140°E on the 2d. It traveled northeastward and organized. By 1200 on the 4th, it was a 970-mb Low and hit 964 mb 24 hr later. Several vessels west of the dateline, including the ***Golden Hawk*** and ***Young Sprout***, encountered 50-to 60-kn winds on the 5th and 6th. Swells ran 8 to 10 ft. Southeast of the center, during this period, the ***Bremen Senator*** and ***Georgia*** also reported 50- to 60-kn winds in 8- to 16- ft seas.

On the 5th, the system turned toward the east northeast but the following day, as it began to weaken, the storm headed northeastward. It moved ashore southeast of Anchorage, on the 7th, as a 977-mb Low. By this time, a Low from Hokkaido intensified as it moved east northeastward. By the 8th, it had a 976-mb center that was cross-

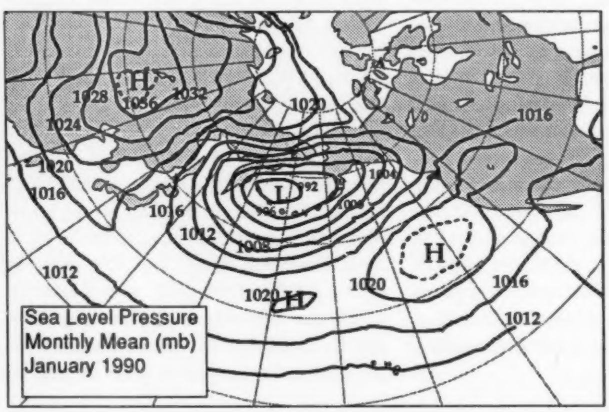


Figure 1.— A near-normal Aleutain Low and a good-size subtropical High were the highlights for January on the North Pacific climatic chart.

ing the 50th parallel near 170°E.

❷ This Hokkaido Low was first detected on the 6th, but really organized on the 8th. By 0000 on the 9th, its 964–mb center headed into the Bering Sea, where it stalled and became a semi–permanent low for several days. At 1800 on the 8th, the *Mys Yegorova* (56°N, 162°W) hit 47–kn westerlies, while 24 hr later the ***Kapitan Redkokasha*** ran into 52–kn northeasterlies, in 14–ft seas, near 61°N, 174°E. These conditions continued into the 10th. The storm remained nearly stationary until the 12th, when a new center developed and carried the circulation northeastward through Bristol Bay and over Alaska.

To the south a ridge of high pressure covered the central North Pacific, and the first tropical cyclone of the year was coming to life. Koryn formed as a tropical depression near the Truk Is, about 600 mi southeast of Guam, on the 12th. Passing about 40 mi east of Guam, on the 14th, it intensified into a severe tropical storm. The following day Koryn weakened and recurved. It accelerated northeastward and became extratropical on the 17th. To the north of Koryn, a powerful system was taking shape.

❸ This system appeared to have incorporated the remnants of Koryn, into its circulation, on the 18th. At 0000 on the 18th, it appears as a 962–mb Low near 45°N, 175°E. The ELLR5, at 0600, reported a 52–kn westerly near 36°N, 172°E; at the same time the ***Prince of Tokyo** 2* ran into 56–kn winds. At 1800 the ***Pine Forest*** (46°N, 174°W) encountered 54–kn southwesterlies in 22–ft seas, and measured a 965–mb pressure. Six hr later the ***Leda Maersk*** (48°N, 171°W) hit 60–kn winds in 20–ft seas. The ***Arnold Maersk*** and the JCDT also encountered storm force winds on the 19th (fig 2). At 0000 on the 19th, the ***Ever Giant*** reported 64–kn west southwest winds, 15–ft seas, 29–ft swells and a 958–mb pressure, southwest of the 946–mb center. The ***Sea Light*** (54°N, 175°W) ran into 52–kn north northeasterlies and measured a 966–mb pressure, while the NRUC (54°N, 179°W) had a 950–mb reading on the 19th, in 36–ft seas. The ***Star Fuji*** (55°N, 179°W) topped out at 64–kn at 0600. Storm force winds were plentiful. This potent storm moved northeastward, and finally showed signs of weakening on the 21st, as it approached Cape Avinof, AK.

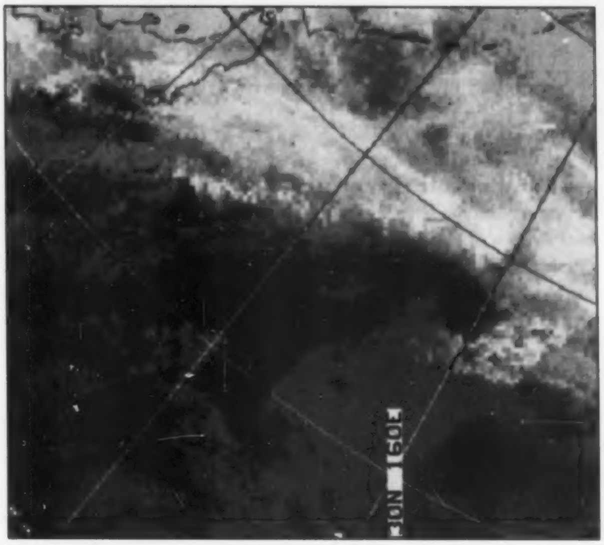


Figure 2.— This nighttime infra–red satellite photo shows the storm, which was generating storm force winds in central North Pacific waters on the 19th.

A mixture of weak low and high pressure areas covered the Pacific on the 22d. Cyclonic activity was prevalent in the Bering Sea and Gulf of Alaska while several Highs dominated the waters south of 40°N. This situation remained prevalent through the end of the month.

Casualties

Early in the month, the 50–ft steel crabber ***Adventure*** sank off Cape Alva. The Coast Guard at Neah Bay received only an auto signal from the emergency locator beacon. They found a liferaft, but not the crew of three. The ***Kara*** was listing at about 20°, in rough South China Sea weather, on about the 8th. The Republic of Singapore Air Force rescued her crew; it is believed that the vessel sank with a $3 million cargo.

A 3–day battle to save a Greek cargo vessel ended in failure on New Year's Eve when the 28–man crew of the 26,645–ton ***Vulca*** abandoned ship, some 800 mi from Hawaii. The vessel was taking on water in heavy seas. The crew was rescued. A report on the 15th, indicated that the bodies of 14 Vietnamese boat people washed ashore in Malaysia after their boat capsized 3 days before, probably, in rough weather.

On the 8th and 9th strong winds and heavy rains created problems in southern Washington State and Oregon. Flooding caused the closing of Highway 101, south of Astoria. Rains also caused mud and rock slides. Three consecutive fronts, with winds up to 75 kn, came ashore, near the mouth of the Columbia River, from the 7th through the 9th. On the 8th, three bulk carriers, the ***Anangel, Honour*** and ***Grand Wood,*** along with a container vessel the ***Swiftnes*** all dragged anchors in the Columbia River but were able to recover.

February— A 1004-mb Aleutian Low was centered in the Gulf of Alaska, well east of its normal position and weaker than usual as well (fig 3). A large double-centered subtropical high covered the North Pacific south of about 45°N. This resulted in a large area of positive anomalies covering the entire North Pacific; a +22 mb maximum turned up near 45°N, 180°. In the steering levels aloft, flow was nearly zonal west of the dateline turning toward the east northeast over the eastern North Pacific.

On This Date

February 25, 1922— The temperature at Los Angeles soared to 92°F, a record for the month.

Ocean Weather

Severe or extreme weather conditions in one area of the world are usually compensated for in another region. As bad as conditions were in the North Atlantic in February, they were that good in the North Pacific. While cyclonic activity was plentiful, particularly in the Gulf of Alaska, most of it was of the weak to moderate variety. A few strong anticyclones made their presence felt over the shipping lanes this month.

The month opened with a large 1033-mb High covering a good portion of the North Pacific, south of 40°N. Low pressure centers appeared in the Gulf of Alaska, over the Aleutians and southeast of Tokyo. The Aleutian and Gulf of Alaska centers combined to generate gales between 175°W and 135°W from 40° to 55°N.

The *Sea-land Defender, Spring Stork* and 3EEVG encountered winds in the 40-to 45-kn range; seas ranged from 12 to 20 ft. By the 2d two of the centers combined in the Gulf and persisted for another day, while the Tokyo Low moved northeastward and intensified.

❶ This Tokyo Low tracked northeastward and, by 1200 on the 3d, crossed 50°N near 170°W, sporting a 972-mb center. At 0600 the ***Hanei Sun***, near 50°N, 173°W, called in a 40-kn easterly, a 978-mb pressure and 20-ft seas. By 1800 she ran into 54-kn northwesterlies and 16-ft seas; her winds hit 56-kn 6 hr later. At the same time, the 3EEV6 hit 45-kn southwesterlies, about 120 mi south of the center. The storm turned toward the east northeast. At 1200 on the 4th, the ***Mobil Meridian*** (54°N 136°W) was rocked by a 50-kn southeasterly; 6 hr later the ***Neptune Crystal*** (52°N, 149°W) battled 20-ft swells in 55-kn northwesterlies. She also measured a pressure of 980 mb (fig 4). The system continued to generate 40-to 50-kn winds, on the 5th, as it moved inland south of Juneau. The storm remained intact as it crossed Canada. On the 11th, its center reformed and merged with another system off Newfoundland to become one of the potent North Atlantic storms.

Meanwhile, back in the Pacific, the High over the eastern waters built to 1048 mb on the 7th. It was the major weather influence west of about 170°W. A stationary front, with several waves, stretched across the Gulf of Alaska and southern Bering Sea. A 990-mb Low approached the dateline, near 42°N, and a weak center formed south of Tokyo.

The dateline Low eventually moved into the Gulf of Alaska, generating gale force winds along the Aleutians on the 9th, as the central pressure dropped briefly to 980 mb. The Low south of Tokyo eventually became organized, and headed northeastward, across the Aleutians, into the Bering Sea. It never became potent, but did maintain its identity as it moved into southwestern Alaska, across the Gulf of Alaska and inland again over Washington. Even this wasn't the end, as the system moved into Texas and through the Ohio Valley; the storm finally called it quits, on the 24th, southeast of old Cape Cod.

The weather chart for the 12th showed a complex scenario across the North Pacific. In the north, several low pressure centers extended from the Gulf of Alaska to Sea of Okhotsk. To the south, a 1038-mb High, in the west, and a 1044-mb High, in the east, were separated by a cold front just east of the dateline. A low pressure center formed along this front, and provided some weather for the Hawaiian Is from the 14th through the 16th. By the 18th, a double-centered Low developed over the northwest, and another extended from the Gulf of Alaska southward. Winds in the vicinity of these systems blew in the 40-to 45-kn range, as reported by such vessels as the ***Med***

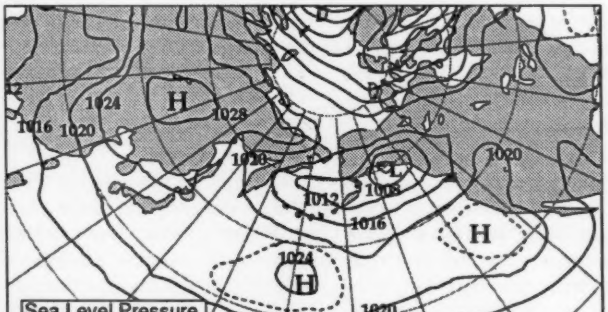


Figure 3.—Notice the Aleutain Low centered in the Gulf of Alaska; this is an indication of a cyclonically active month in this region. The Low, however, was not as strong as it normally is in February, while the subtropical high dominates a good portion of the North Pacific.

Figure 4.— The Tokyo Low was picked up by satellite, at about 2100 on the 4th, as it moves into the northeastern North Pacific. The central pressure was around 980 mb, at this time, and the storm was generating storm force winds. This system later became a potent North Atlantic storm.

the ***Chevron California*** hit storm force winds, before the system began to weaken. It turned toward the east northeast and into the Bering Sea as the month came to a close.

Casualties

Compared to the North Atlantic, February was an easy month in this basin. The only report of heavy weather damage was at Captains Bay near Dutch Harbor, AK. Five vessels at the Pacific Alaska Fuel Services Dock, were pounding against the dock, as heavy swells rocked the area. The fishing vessel ***Starbound*** and the ***Miyashima Maru*** sustained some damage before getting away. The Royal Observatory at Hong Kong reported that fog on the 19th resulted in the hydrofoil ***Flying Albatross*** running aground at Deep Bay.

Sky, OOCL Fair, Shaugran, Zareche and the ***Washington Highway***. In between these systems was a 1038–mb High, which was helping to create tight pressure gradients on both its east and west sides.

This situation slowly deteriorated as the western Low gradually moved north of the High, and became part of the eastern conglomerate, which had stalled. It wasn't until the 23d that a recognizable storm center became organized.

❷ This system came to life on the 21st as an atmospheric wave, along a front, northwest of the Hawaiian Is. After moving northeastward and then northward, it developed into a 980–mb Low, by 1200 on the 23d. Ship reports confirmed this development. The ***Hanei Sun*** (52°N, 167°W), at 0600, ran into a 44–kn north northeasterly, 18–ft swells and a 981–mb pressure, about 120 mi northwest of the center. At 1200 the ***Miller Freeman*** hit 48–kn northeasterlies near 57°N, 153°W; 6 hr later winds dropped to 40 kn, while she rolled in 20–ft swells. At this time, the *Hanei Sun* encountered 48–kn northerlies, in 18–ft swells. By 0000 on the 24th, 10 vessels hit 40–to 50–kn winds, between 45° and 55° N from 155° W to the dateline. As this system moved ashore on the 24th, another less potent center took its place near 45°N, 165°W. Also, at about this time, a Low developed over Honshu.

❸ This storm formed over Honshu on the 24th. It traveled northeastward, paralleling the Kuril Is and Kamchatka Peninsula, for the next several days. Vessels in its vicinity reported winds in the 40–kn range on the 25th and 26th. At 0600 on the 27th, the ***President Madison***, near 53°N, 167°E, hit 50–kn southwesterlies in 16–ft swells, and reported a 986–mb pressure. Six hours later the storm's central pressure fell to 980 mb, and it turned eastward. The ***Henry Hudson Bridge*** and WRYC reported 49–kn west southwesterlies in 10–to 15–ft seas. On the 28th, the WRYC and

March— The Aleutian Low was centered a little northwest of its usual position (fig 5), and the subtropical high was a little more extensive than normal. This resulted in positive anomalies of up to 6 mb centered near 45°N, 165°W, and extending over the eastern North Pacific, including the Gulf of Alaska. According to the Royal Observatory at Hong Kong, weather in their region was dryer and brighter than it was during the first 2 mo. Apart from the last 10 days of the month, the daily mean pressure stayed consistently on the high side, as a continental anticyclone prevailed over China. The monthly mean pressure of 1018.2 mb at Hong Kong turned out to be the fifth highest on record for March.

In the steering levels, a low pressure trough was centered over the Kamchatka Peninsula, and some troughing was evident from the Alaska Peninsula southeastward. This resulted in a pattern that would take a storm

from Tokyo and steer it over Washington State.

On This Date

March 26, 1923— The 982-mb center of a slow moving typhoon passed south of Guam bringing a maximum 24-hr rainfall of 4.84 in. to Sumay. Winds gusted to well over typhoon force; the majority of the damage occurred in the south, where bridges and roads washed away. No loss of life was reported.

Ocean Weather

The month opened with a 1032-mb High over the central ocean, a 984-mb Low moving across the southern Bering Sea and a 996-mb Low in the eastern waters. A wave was also coming to life along a front south of Tokyo.

Figure 6.— Another Tokyo Low, similar to last month, heads toward the Gulf of Alaska. This shot was taken about 1500 on the 5th. The storm eventually turned southeastward and moved ashore near Prince Ruppert Is, British Columbia on the 7th.

❶ This Tokyo Low headed east northeastward on the 1st. It developed slowly, and turned northeastward late on the 3d, remaining west of the High. Shortly after 1700 on the 4th, the 974-mb center crossed the 50th parallel near 157°W. By 1200 on the 5th, the pressure dipped to 960 mb. In general, winds blew at 40 to 50 kn, and swells were 20 to 30 ft. However, at 0000 on the 5th, near 50°N 151°W, the WAFA reported a 75-kn southwesterly, 36-ft swells and a 974-mb pressure. Other reporting vessels included the ELJQ7, ***Mobil Arctic***, FCSK, ***Great Land*** and the BKJJ.

At the same time, another Low, off the Kamchatka Peninsula, generated 40-to 50-kn winds, from 45° to 55°N, between 150°E and the dateline. This storm was most noticeable on the 5th and 6th.

Meanwhile, the Tokyo Low moved into the Gulf of Alaska on the 6th, before coming ashore near Prince Ruppert, British Columbia late the following day (fig 6). Storm force winds occurred through the 6th. At 1800 the ***Tatekawa Maru*** (54°N,150°W) ran into 52-kn west northwesterlies in 25-ft swells. Conditions improved the following day.

By the 8th, a 1040-mb High had situated itself over the eastern North Pacific, while a 1030-mb High over China extended eastward into the Philippine Sea. Several low pressure centers developed from Hokkaido through the eastern Bering Sea. Two of the Bering Sea centers ended up as one 978-mb Low in the Gulf of Alaska, on the 10th, while the Hokkaido storm interfered with shipping in north- central waters.

❷ The Hokkaido storm came to life, on the 7th, in the Sea of Japan. After moving eastward, it swung east northeastward and intensified. By the 9th, it was a 972-mb storm; the ***Shearwater***, UPSU and ***Mackinac Bridge*** encountered 40-to 50-kn winds in 5-to 18-ft seas. At 0600 on the 9th, the ***Toyofuji No. 14***, in the storm's northwest quadrant, ran into a 62-kn northwesterly in 18-ft swells. The ***Kvarner***, in the same area, reported a 64-kn west northwesterly, 26-ft swells and a 973-mb pressure. The SGC4 caught 59-kn northwesterlies, near 41°N, 151°E, at the same time. The storm crossed the dateline on the 11th near 48°N. By this time, maximum winds were running about 40-kn as the central pressure climbed to 984 mb. The system continued weakening as it moved across the Alaska Peninsula on the 13th. By this time, another Hokkaido system was coming to the fore.

❸ This was a short lived system, but it made an impact on shipping on the 13th and 14th. The storm developed into a 982-mb Low, just east of Hokkaido, on the 12th. Early the following day, its pressure dropped to 975 mb. Conditions were bad to the south of the center, where the ***Tokyo Maru***, ***Kyushu***, ***Sugura Maru***, ***Ilya Ilin*** and the ***Kapitan Markov*** hit 45-to 55-kn winds in 8-to 13-ft seas. The ***Ilya Ilin*** (45°N, 146°E) ran into a 58-kn northerly, at 0600, in 20-ft swells. The ***Kapitan Markov***, ***Ilya Ilin*** and the ***Wolfsburg*** also

hit storm force winds, at this time. The storm paralleled the Kuril Islands and Kamchatka Peninsula on the 13th and 14th. On the 14th, there were fewer storm reports, but gale observations were plentiful. At 1200 the *Century Highway No. 5* (45°N 160°E) came in with a 52–kn northwest wind. The associated frontal system was also generating storm force winds into the 15th.

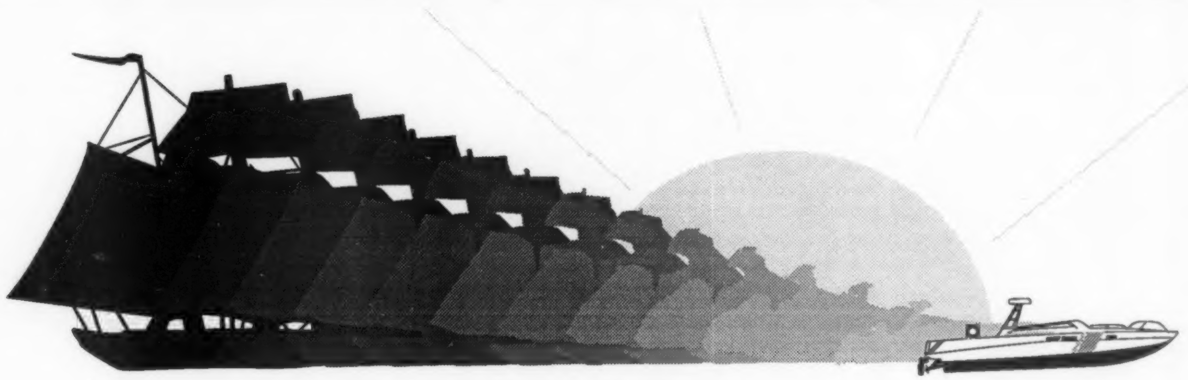
Another Low intensified on the 16th near 40°N, 158°E. At 0000 several ships were reporting storm force winds mainly south and southwest of the center, which was moving north northeastward. The *Tokyo Highway* (36°N, 160°E) battled 56–kn south southwesterlies, and 20–ft swells. The *Bergen Arrow* hit 58–kn west northwest winds in 18–ft swells, near 50°N, 163°E. At 1800 the *Kovdales* (48°N, 153°E) reported a 60–kn easterly. The storm stalled just east of the Kamchatka Peninsula, on the 17th. It remained potent, generating storm force winds mostly over the Sea of Okhotsk, and gales elsewhere. It wasn't until the 20th that it moved across the Kamchatka Peninsula and into the Sea of Okhotsk; by this time it was weakening.

On the 21st three low pressure systems blanketed the North Pacific, north of 30°N. Scattered gale reports were received, but none of the systems was all that potent. In fact, the center that headed toward the Gulf of Alaska was soon encompassed by a storm, which had formed off Tokyo on the 18th. A third center, from the northern Sea of Japan, fizzled by the 21st. On the 23d, two high pressure systems were located on either end of the basin, while two lows covered the central waters. However, to the west was a trough in the East China Sea, which gave rise to the last major system of the month.

❶ This storm was first detected on the 23d near 32°N, 120°E. As the High to the east pushed southeastward, this low quickly developed a circulation, and moved into the Pacific east of Honshu. By the 26th, it crossed the 45th parallel near 165°E. It really intensifiedbetween 1200 on the 26th and 1200 on the 27th, when a 980–mb central pressure dropped to 964 mb. By 0600 on the 27th, it was starting to get the attention of shipping. That's when the *Alain L D*, about 300 mi southeast of the center, ran into 56–kn west southwesterlies in 20–ft seas. Other vessels were reporting winds in the 45–to 50–kn range. At 1800 the *Alain L D* came in with 68–kn winds, while still battling 20–ft seas, as the storm continued northeastward. This fight continued right into the 28th. The only other nearby reporting vessel was the WGJC, which encountered 40–kn westerlies, near 46°N, 178°E, at 1800 on the 27th. The central pressure remained at 964 mb, through most of the 28th, as the storm made its way into the Bering Sea. However, it began to fill the following day. It did retain its identity until the month closed.

Casualties

The coaster *Shoju Maru No. 5*, 199 tons gross, Kurosaki for Fukuyama, in ballast, ran aground off Niihama, at 0110 on the 20th. The vessel was refloated with assistance the same day.

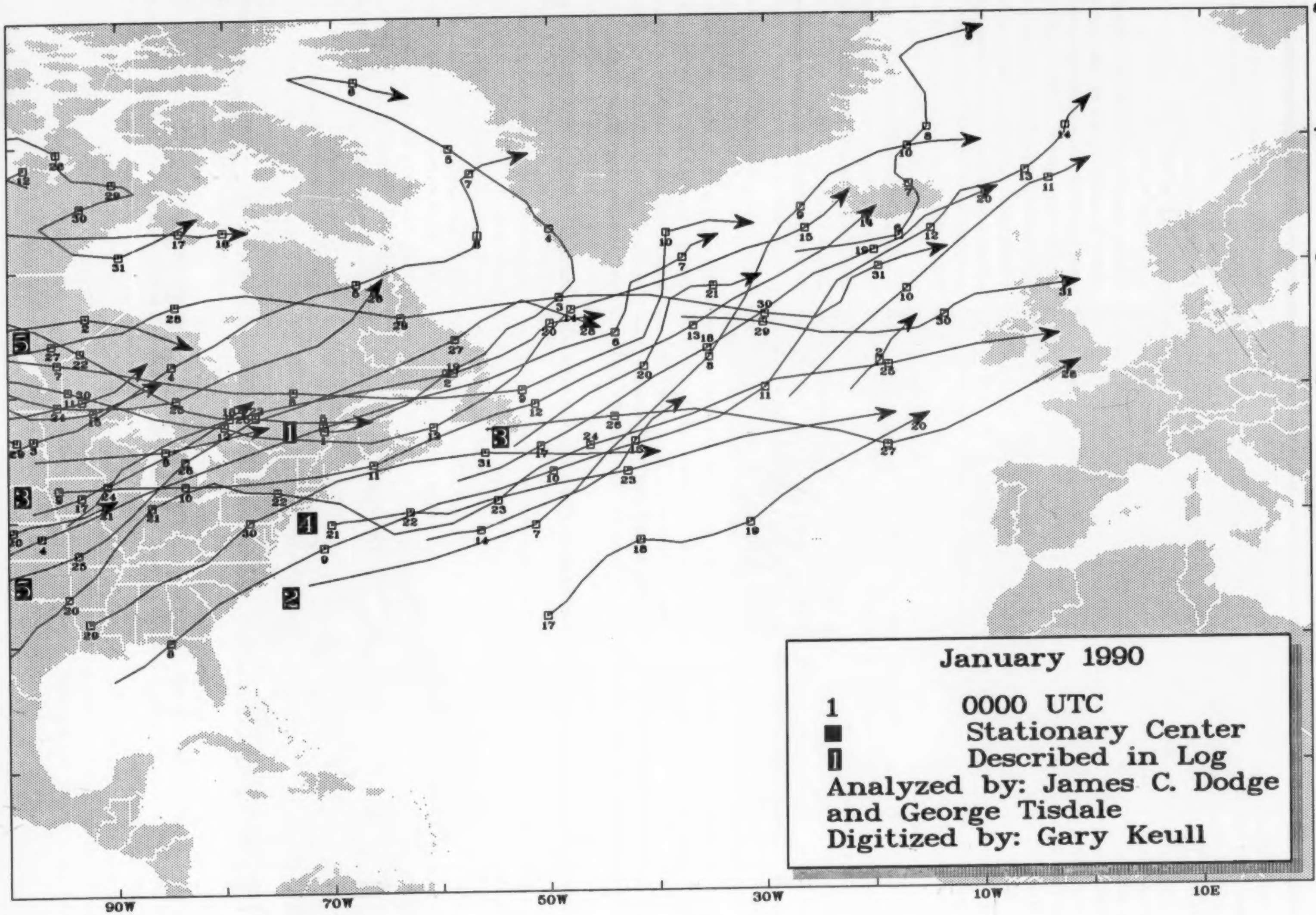


U.S. Coast Guard

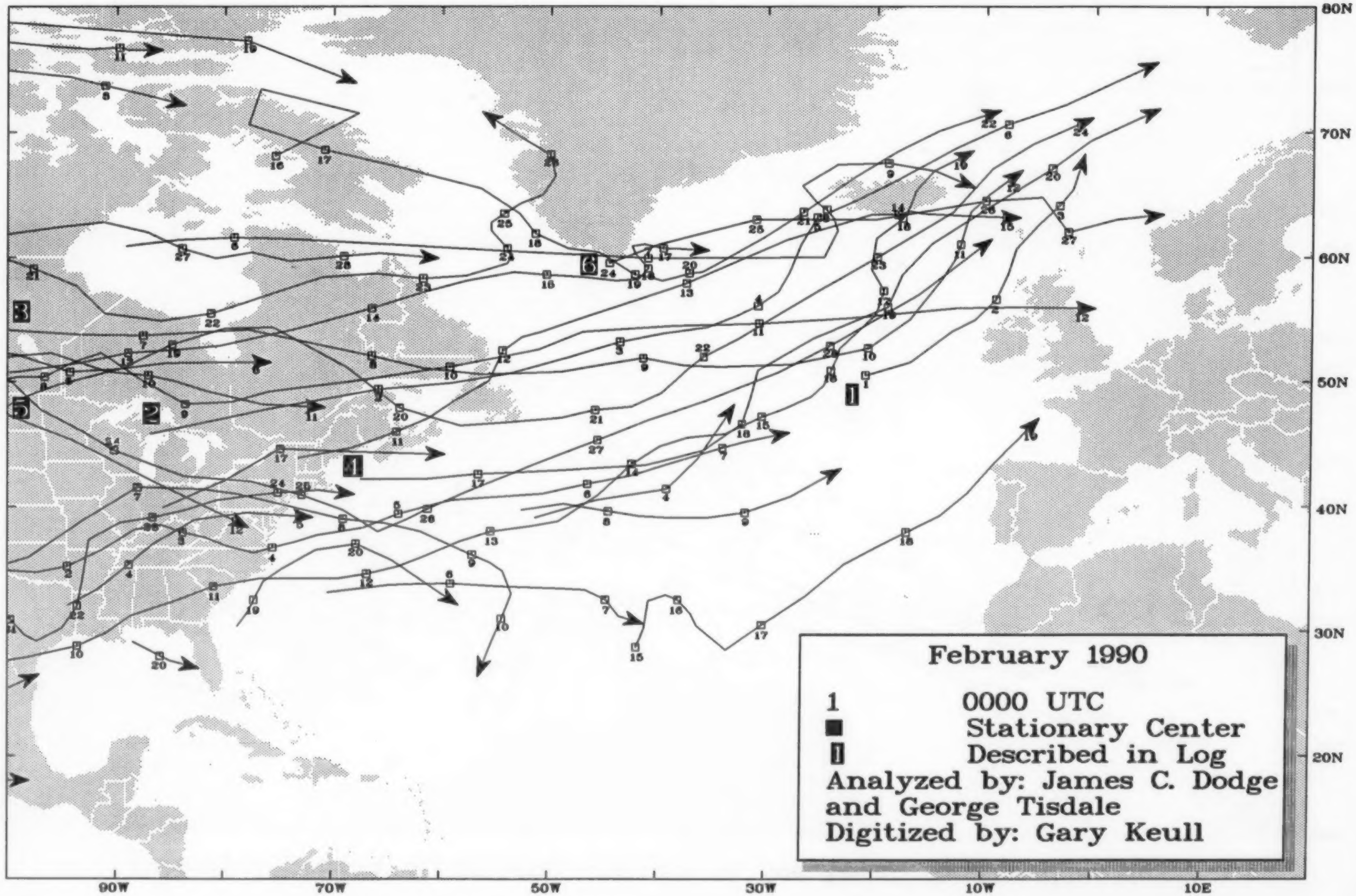
200 Years of Service

1790 – 1990

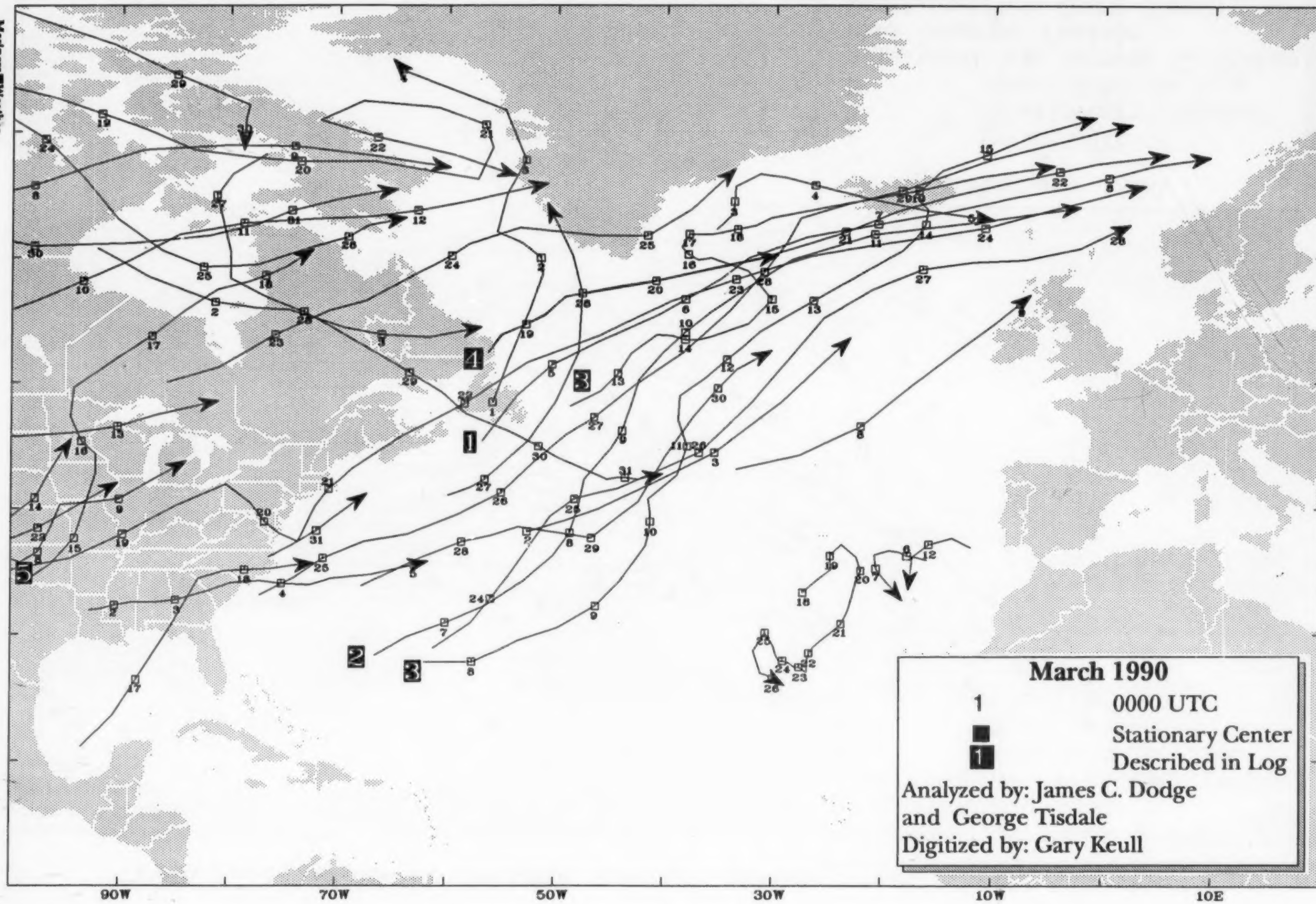
Principal Tracks of Cyclone Centers at Sea Level, North Atlantic



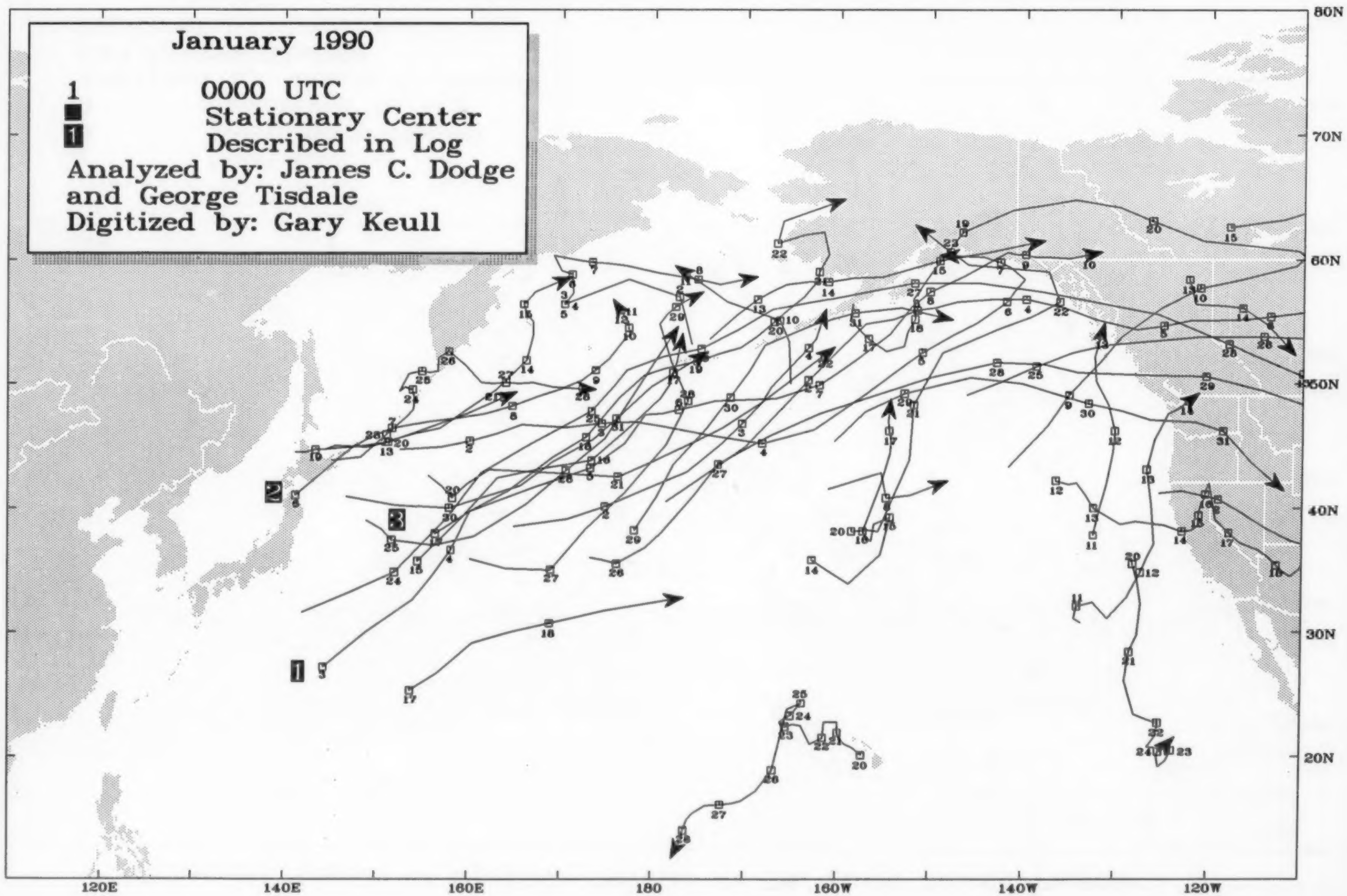
Principal Tracks of Cyclone Centers at Sea Level, North Atlantic



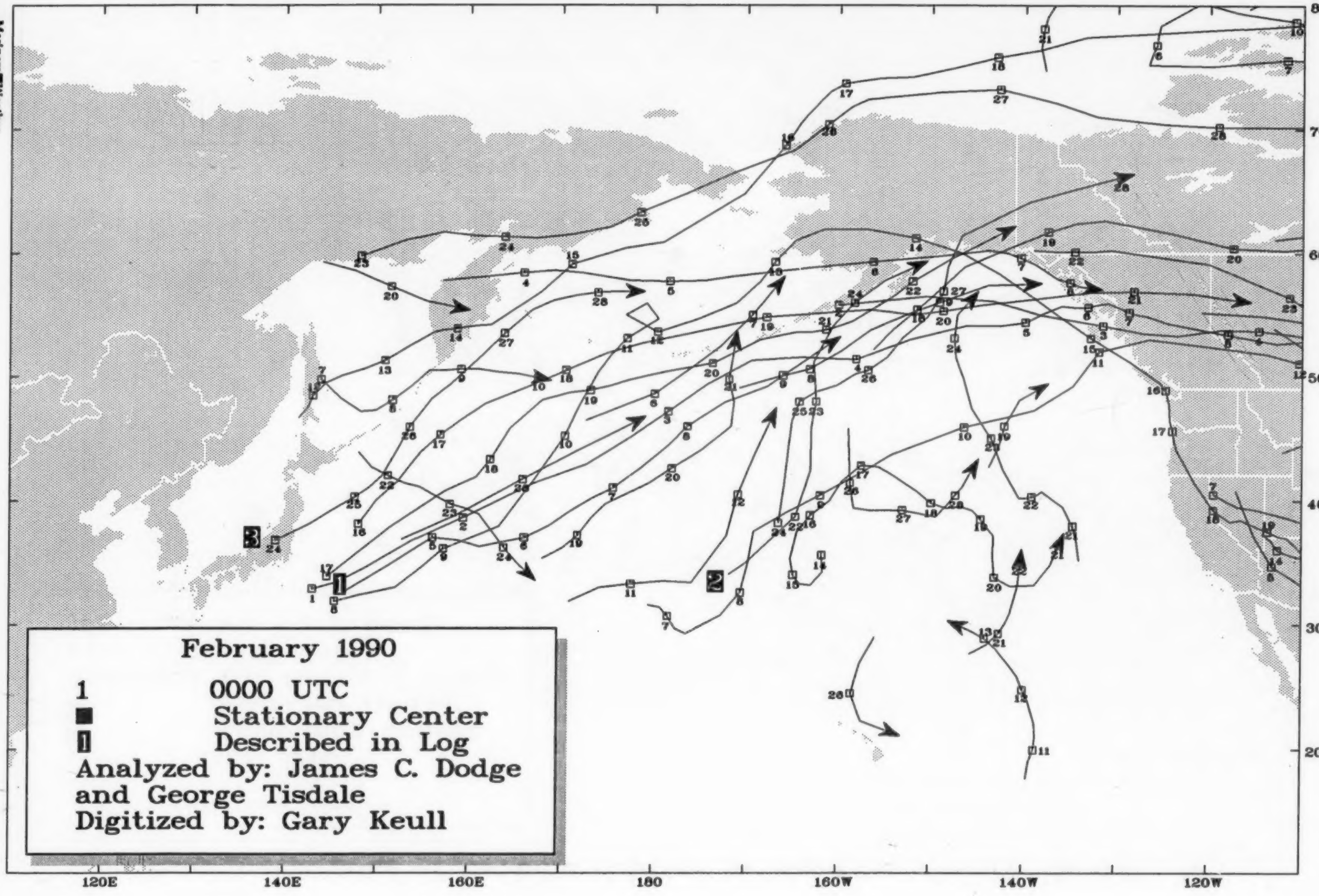
Principal Tracks of Cyclone Centers at Sea Level, North Atlantic



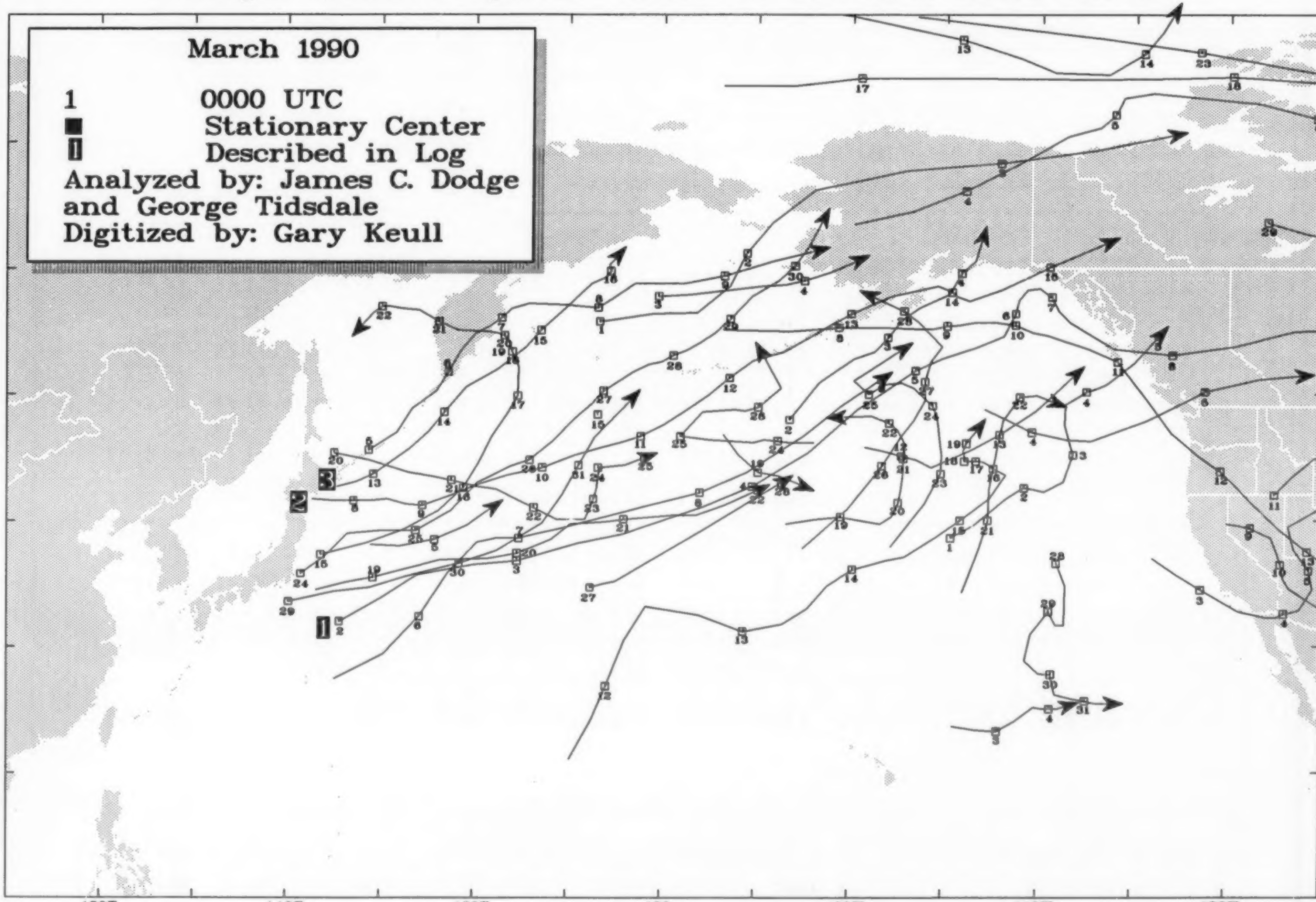
Principal Tracks of Cyclone Centers at Sea Level, North Pacific



Principal Tracks of Cyclone Centers at Sea Level, North Pacific



Principal Tracks of Cyclone Centers at Sea Level, North Pacific



January, February and March 1990

VESSEL	SHIP CALL	DATE	POSITION LAT. deg.	POSITION LONG. deg.	TIME GMT	WIND DIR. 10 deg.		WIND SPEED kn.	VSBY	PRES WX. code	PRESSURE mb.	TEMP deg C. Air	TEMP deg C. Sea	SEA WAVES PD. sec	SEA WAVES HGT. ft.	SWELL WAVES DIR	SWELL WAVES PD. sec	SWELL WAVES HGT. ft.
PACIFIC JAN.																		
SKAUBORD	LADC2	2	54.4 N	154.4 W	18	25	M	49	1 NM	61	0986.0	4.0	5.5	9	31	25	10	31
SAN MATEO VICTORY	DZPT	3	44.1 N	171.5 W	00	25		50	> 25 NM		0986.0	5.5	9.0	10	24.5	25	9	39
WHITE ROSE	3EIS3	4	44.4 N	174.3 E	18	14	M	45	1 NM	63	0980.0	9.0	9.0	7	23	14	7	29.5
WHITE ROSE	3EIS3	6	45.1 N	179.5 W	00	27	M	53	2 NM		0980.0	7.5	10.0	8	19.5	27	10	29.5
KEYSTONE CANYON	KSFK	9	44.0 N	126.7 W	12	19		45	5 NM		1003.0	12.8	11.1	10	23	29	20	29.5
PRESIDENT TYLER	WEZM	14	52.9 N	175.5 E	12	23	M	50	10 NM	02	0988.0	- 0.6	2.2	6	21	24	8	29.5
NATIONAL DIGNITY	DZRG	14	48.7 N	155.0 E	18	27	M	50	< 50 YD	73	0993.0	- 4.0	2.0	20	36	27	22	39
PRESIDENT TYLER	WEZM	15	52.2 N	172.6 E	00	21	M	50	5 NM		0978.0	- 2.8	2.2	6	28	23	7	29.5
SEALAND INNOVATOR	WGKF	15	49.4 N	161.9 E	00	22	M	58	1 NM	74	0983.0	4.4		7	29.5	22	8	39
PRESIDENT TYLER	WEZM	15	52.8 N	171.5 E	12	24	M	48	5 NM	86	0976.5	- 2.8	2.8	6	26	24	12	49
NEW RUBY	ELLR5	18	36.4 N	172.3 E	06	27	M	52			0999.5	9.0		6	24.5	27	6	32.5
NEW RUBY	ELLR5	18	36.2 N	175.0 E	18	27	M	48	5 NM	01	1009.5	9.0		6	24.5	27	6	29.5
PINE FOREST	YJXL4	18	46.1 N	173.5 W	18	22	M	54	2 NM	25	0965.0	6.5	6.0	16	36	21	16	37.5
EVER GIANT	3FRI2	19	46.6 N	177.4 E	00	24	M	64	.25 NM	80	0958.0	4.0		9	24.5	25	18	44
ARNOLD MAERSK	OZGI2	19	42.1 N	172.6 E	00	29		45	5 NM	27	1003.2	3.0		7	16.5	30	14	32.5
PINE FOREST	YJXL4	19	46.4 N	171.7 W	00	21	M	53	2 NM	40	0965.5	6.5	5.0	16	41	21	16	41
LEDA MAERSK	OULU2	19	48.5 N	167.6 W	06	22	M	50	2 NM	07	0968.0	6.0		11	26	22	XX	32.5
PINE FOREST	YJXL4	19	46.7 N	169.9 W	06	22	M	54	2 NM	25	0972.0	6.0	5.0	16	37.5	22	17	39
PINE FOREST	YJXL4	19	46.9 N	167.9 W	12	22	M	47	2 NM	24	0975.5	5.0	5.0	14	34.5	22	14	34.5
PINE FOREST	YJXL4	20	47.5 N	164.2 W	00	22	M	45	2 NM	40	0983.0	6.0	5.0	14	32.5	22	14	32.5
ANDERS MAERSK	OXIT2	20	54.2 N	162.9 W	06	20		45			0963.0	5.0		4	6.5	19	7	29.5
ARCTIC TOKYO	5LJT	25	53.2 N	172.4 E	12	06	M	62	.25 NM	57	0986.0	0.0	4.0	8	29.5			
ARCTIC TOKYO	5LJT	25	53.3 N	173.0 E	18	06	M	59	50 YD	45	0982.0	0.0	4.0	8	29.5			
ARCTIC TOKYO	5LJT	26	53.3 N	173.8 E	00	06	M	46	2 NM		0981.0	0.0	4.0	10	41			
BROOKS RANGE	WSRP	30	45.5 N	127.8 W	18	30		45	10 NM		0999.0	8.3	10.6	7	13	29	9	36
BROOKS RANGE	WSRP	31	48.7 N	131.1 W	18	28		45	5 NM		0978.0	7.8	7.2	6	13	15	8	29.5
ATLANTIC JAN.																		
FAUST	WRYX	21	44.8 N	43.0 W	00	27	M	45	5 NM	02	1013.0	3.0	14.4	6	19.5	27	8	32.5
LAURA MAERSK	OYBF2	28	58.8 N	39.5 W	06	08		48	< 50 YD	75	0956.0	2.0		12	26	07	16	29.5
CHARLOTTE LYKES	WPHZ	29	44.7 N	35.6 W	12	28		45	10 NM	01	1011.5	11.1	12.0	10	37.5	28	10	41
MSC SABRINA	IBPA	30	43.2 N	17.0 W	06	27		46	5 NM	02	1004.0	14.0	14.0	12	29.5			
GALVESTON BAY	WPVF	30	45.6 N	29.8 W	06	26		60	2 NM	13	0992.0	12.0		12	26	27	15	39
MSC SABRINA	IBPA	30	43.0 N	18.4 W	12	27		48			0999.0	16.0	14.5	14	31			
CHARLOTTE LYKES	WPHZ	30	44.3 N	26.7 W	12	28		56	5 NM	89	0997.8	8.3	12.0	8	39	27	10	39
MSC SABRINA	IBPA	31	42.6 N	20.9 W	00	27		48			0999.5	11.5	14.0	14	29.5			
CHARLOTTE LYKES	WPHZ	31	43.7 N	22.5 W	00	28		49	5 NM	13	0996.8	10.0	12.0	XX	34.5	28	XX	37.5
MSC SABRINA	IBPA	31	42.6 N	22.0 W	06	27		48			1006.0	11.0	14.0	14	29.5			
PACIFIC FEB.																		
RANIER	D9BW	5	52.7 N	145.6 W	00	29	M	54	.5 NM		0982.0	5.0	8.0	12	32.5	29	15	32.5
RANIER	D9BW	5	52.5 N	146.8 W	12	30	M	57			1001.0	2.0	9.0	12	32.5	29	15	32.5
CORNUCOPIA	KPJC	5	52.4 N	137.1 W	12	31		46	10 NM		0981.0	2.1	8.8	5	13	31	12	29.5
CORNUCOPIA	KPJC	5	53.0 N	138.1 W	18	30		46	5 NM	21	0988.1	1.0	6.2	4	13	30	11	29.5
CORNUCOPIA	KPJC	6	53.1 N	138.8 W	00	29		46	10 NM	02	0994.0	- 2.5	6.1	4	13	30	11	29.5
PRESIDENT KENNEDY	WRYE	7	39.3 N	174.5 E	12	29	M	54	5 NM	25	1001.0	7.0	12.6	4	19.5	26	9	29.5
PRESIDENT KENNEDY	WRYE	7	39.3 N	171.9 E	18	33	M	50	5 NM	07	1016.0	6.5	13.2	4	19.5	33	9	29.5
SEALAND EXPRESS	KGJD	11	52.6 N	149.5 W	00	30	M	50	5 NM	02	1020.0	- 1.0		13	32.5	32	13	32.5
SEALAND EXPRESS	KGJD	11	52.4 N	146.2 W	06	30	M	46	5 NM	02	1020.0	- 1.0		13	32.5	31	13	32.5
NOSAC EXPRESS	LAZA2	12	49.7 N	132.5 W	00	30	M	45	5 NM		1020.0	2.5	8.0	5	16.5	30	8	32.5
SEALAND HAWAII	KIRF	13	32.0 N	142.5 W	00	08		48	2 NM	65	1012.0	17.8	18.3	12	32.5	18	12	32.5
SEALAND HAWAII	KIRF	13	32.0 N	142.4 W	03	09		48	2 NM	65	1013.3	16.7	18.3	12	36			
SEALAND HAWAII	KIRF	13	32.0 N	142.0 W	06	09		48	2 NM	65	1015.0	16.7	18.3	12	36			
PINE FOREST	YJXL4	24	51.2 N	170.6 W	00	36	M	56	200 YD	85	0995.0		3.0	15	39	01	15	39
PINE FOREST	YJXL4	24	50.0 N	171.4 W	06	01	M	47	50 YD	26	1001.5	1.5	3.0	14	41	01	14	41
CHEVRON CALIFORNIA	WCGN	28	58.5 N	149.9 W	00	28	M	55	10 NM	16	1004.0	4.4	3.3	7	29.5	28	7	10
ATLANTIC FEB.																		
SEALAND COMMITMENT	KRPB	1	47.8 N	10.1 W	12	23	M	48	.5 NM	62	0986.0	13.3	12.2	10	19.5	25	10	32.5
SEALAND COMMITMENT	KRPB	1	47.4 N	10.9 W	18	27	M	55	.5 NM	81	0994.0	9.4	12.0	10	21	27	12	29.5
SEALAND QUALITY	KRNJ	3	50.4 N	45.5 W	18	26	M	46	.25 NM	73	0965.5	- 1.1	9.7	3	13	28	6	32.5
SEALAND QUALITY	KRNJ	4	49.3 N	47.2 W	00	33	M	55			0980.0	1.1	9.3	4	13	32	6	31
SEALAND QUALITY	KRNJ	4	48.1 N	48.8 W	06	31	M	48	.5 NM	72	0997.0		5.4	4	13	32	6	32.5
GALVESTON BAY	WPVF	11	45.8 N	14.5 W	00	29		47	5 NM	80	1021.0	10.0		12	24.5	29	12	32.5
GALVESTON BAY	WPVF	11	45.2 N	15.9 W	06	24		46	5 NM	03	1015.4	13.1		12	26	28	15	29.5
CHARLOTTE LYKES	WPHZ	11	47.4 N	09.4 W	12	25		52	2 NM	81	1000.0	11.5	10.0	6	23	27	10	29.5
GALVESTON BAY	WPVF	11	44.6 N	17.4 W	12	25		48	5 NM	05	1017.0	14.4		12	26	28	15	29.5
CHARLOTTE LYKES	WPHZ	12	46.9 N	10.6 W	00	30		56	5 NM	01	1006.9	10.6	10.0	XX	41	34	XX	44
MARIT MAERSK	OZFC2	15	46.6 N	36.4 W	14	22	M	46	2 NM		1000.4	12.0	12.9	7	32.5			
MORMACSUN	WMBK	21	41.1 N	35.0 W	00	22		45	2 NM	82	1000.0	15.0	13.3	8	24.5	22	10	32.5
MORMACSUN	WMBK	21	41.2 N	35.2 W	06	24		45	2 NM	13	0996.4	16.2	14.0	8	24.5	23	10	32.5
JEBEL ALI	9KJP	21	33.1 N	40.8 W	12	22	M	45	5 NM		1014.0	21.0	20.5	8	16.5	26	14	39
PACIFIC MAR.																		
EXXON BATON ROUGE	WAFA	5	49.6 N	150.8 W	00	23		75	.25 NM		0974.0	3.9	5.6			23	13	36
MC KINNEY MAERSK	OWEQ2	11	41.1 N	172.7 E	00	27		50	10 NM		0984.0	9.5	13.5	6	29.5	27	8	32.5
ARNOLD MAERSK	OZGI2	13	35.3 N	144.9 E	06	29		45	5 NM		1008.4	9.5	16.0	10	41			
SKAUBORD	LADC2	15	45.9 N	176.9 W	12	16	M	48	2 NM	07	1008.0	6.0	5.5	7	29.5	16	8	31
GREEN MAYA	3ETA5	21	54.2 N	153.3 W	00	08	M	45	2 NM	41	1015.0	5.0	3.5	10	19.5	08	15	31
CHEVRON CALIFORNIA	WCGN	21	52.3 N	149.3 W	06	10		50	2 NM	62	1005.5	3.9	3.9	9	32.5			
ATLANTIC MAR.																		
NONE																		

January, February and March 1990

Ship Name	radio	mail
1ST LT ALEX BONNYMAN	78	48
2ND LT. JOHN P. BOBO	2	
A. V. KASTNER	97	
ABBEY	184	
ACADIA FOREST	3	38
ACE ACCORD	77	14
ACT 11	29	
ACT 111	144	
ACT 12	12	
ACT 5	144	
ACT 6	86	
ACT 7	152	
ACT I	76	
ACT IV	29	
ADABELLE LYKES	86	115
ADDIRIYAH	111	65
ADMIRALTY BAY	38	93
AEL AMERICA	9	
AEL EUROPA	123	
AFRICAN FERN	84	12
AINO	36	
AL AHMADIAH	1	
ALASKA RAINBOW	18	50
ALBERT MAERSK	8	7
ALDEN W. CLAUSEN	29	160
ALEMANIA EXPRESS	45	
ALLIGATOR FORTUNE	13	22
ALLIGATOR GLORY	37	32
ALLIGATOR HOPE	31	106
ALLIGATOR LIBERTY	78	
ALLIGATOR PRIDE	71	133
ALLIGATOR TRIUMPH	34	135
ALMERIA LYKES	52	30
ALPHA HELIX	141	98
ALTAMONTE	43	27
ALVA MAERSK	6	22
AMBASSADOR BRIDGE	56	22
AMBER PACIFIC		167
AMERICA EXPRESS	74	
AMERICA MARU	176	
AMERICAN CONDOR	27	39
AMERICAN CORMORANT	7	
AMERICAN EAGLE	75	81
AMERICAN FALCON	45	72
AMERICAN REPUBLIC	2	
AMERICAN TRADER	18	65
AMERIGO VESPUCCI	50	46
ANASTASTS		15
ANDERS MAERSK	67	146
ANTHONY RAINBOW	28	63
AQUA CITY	72	150
AQUA GARDEN	54	35
ARCO ALASKA	14	36
ARCO ANCHORAGE	19	31
ARCO CALIFORNIA	21	28
ARCO FAIRBANKS	41	30
ARCO INDEPENDENCE	8	
ARCO JUNEAU	24	8
ARCO PRUDHOE BAY	16	
ARCO SAG RIVER	16	27
ARCO SPIRIT	26	23
ARCO TEXAS	17	58
ARCTIC OCEAN	7	40
ARCTIC TOKYO	81	190
ARGONAUT	49	143
ARGUS EXPLORER	8	
ARILD MAERSK	41	172
ARNOLD MAERSK	42	130
ARTHUR M. ANDERSON	28	15
ASHLEY LYKES	7	
ASPEN	29	100
ASTERIKS	12	
ASTORIA	97	
ASTRO JYOJIN	11	124
ATIGUN PASS	80	94
ATLANTIC	5	
ATLANTIC CARTIER	115	
ATLANTIC COMPANION	58	
ATLANTIC CONVEYOR	109	
ATLANTIC OCEAN	38	61
ATLAS HIGHWAY	42	16
AURORA ACE	103	
AUSTANGER	2	4
AUSTRAL RAINBOW	5	38
B.T. SAN DIEGO	94	196
BADGER	30	81
BAJKA	60	54
BALTIMORE TRADER	13	
BARRYDALE	120	
BAY BRIDGE	148	102
BCR KING	26	
BEBEOURO	31	
BEER SHEVA	20	
BELGIAN SENATOR	34	
BELLFLOWER	25	
BIBI	163	
BISLIG BAY	10	
BLUE HAWK	103	
BOBEL STAR	10	35
BOGASARI EMPAT	17	50
BOHOL SAMPAGUITA	66	98
BOW SELENE		77
BRIGIT MAERSK	8	117
BRILLIANCY	15	68
BRILLIANT ACE	150	
BROOKLYN		60
BROOKLYN BRIDGE	83	
BROOKS RANGE	28	57
BUGANA KANTAN	17	76
BUNGA KENANGA	41	
BUNGA MELAWIS	7	
CALGA	29	
CALIFORNIA HERMES	10	6
CAPE BYRON	16	
CAPE HENRY	65	
CAPE YORK	127	
CAPRICORN		6
CARIBAN	122	164
CARIBE 1	1	46
CARLA A. HILLS	6	148
CAROL	55	118
CAROLINA	63	164

Ship Name	radio	mail
CASON J. CALLAWAY	2	
CATTLEYA ACE		131
CELEBRATION	39	52
CENTURY HIGHWAY #2	314	117
CENTURY HIGHWAY NO. 5	267	78
CGM CHAMPAGNE	8	
CGM LORRAINE	38	
CHABLIS	76	133
CHACO	1	
CHALLENGER	109	
CHARLES E. WILSON	8	
CHARLES PIGOTT		24
CHARLESTON	45	84
CHARLOTTE LYKES	118	213
CHELSEA	30	74
CHEMICAL PIONEER	75	68
CHERRY VALLEY	64	90
CHESAPEAKE TRADER	65	135
CHESNUT HILL	1	9
CHEVRON ANTWERP	10	
CHEVRON ARIZONA	18	
CHEVRON CALIFORNIA	115	120
CHEVRON COLORADO	32	56
CHEVRON COPENHAGEN	1	45
CHEVRON EDINBURGH	11	186
CHEVRON EQUATOR	16	33
CHEVRON FELUY		72
CHEVRON LONDON		86
CHEVRON LOUISIANA	27	46
CHEVRON METEOR	33	107
CHEVRON MISSISSIPPI	66	165
CHEVRON OREGON	37	52
CHEVRON PACIFIC	43	174
CHEVRON SKY		128
CHEVRON STAR		88
CHEVRON SUN	1	258
CHICKASAW	6	28
CHINA CONTAINER	107	113
CHRISTINA	97	
CITADEL HILL	1	
CLARENCE	47	
CLEMENT	45	
CLEVELAND	32	63
COAST RANGE	91	34
COASTAL MANATEE	2	
COLIMA	20	24
COLUMBINE	37	20
COLUMBUS AMERICA	259	
COLUMBUS AUSTRALIA	66	
COLUMBUS CANADA	203	
COLUMBUS LOUISANA	247	
COLUMBUS NEW ZEALAND	115	
COLUMBUS OHIO	16	
COLUMBUS OLIVOS	37	
COLUMBUS OREGON	81	
COLUMBUS QUEENSLAND	106	
COLUMBUS VICTORIA	144	
COLUMBUS VIRGINIA	161	
COLUMBUS WELLINGTON	126	
CONCERT EXPRESS	59	
CONTINENTAL HIGHWAY	52	
CONTSHIP AUSTRALIA	74	
CORAH ANN	94	61
CORMORANT ARROW	50	28
CORNUCOPIA	50	184
CORONADO	15	
CORWITH CRAMER	38	
CPL. LOUIS J. HAUGE JR	32	46
CRISTOFORO COLOMBO	33	34
CSS HUDSON	146	
CYPRESS PASS	16	
D.L. BOWER		17
DAVID PACKARD	1	
DELAWARE TRADER	36	73
DIANA		13
DILIGENCE TRADER	28	26
DIRECT EAGLE	75	169
DON JORGE		47
DUSSELDORF EXPRESS	67	
DYVI OCEANIC		72
EASTERN GLORY	58	82
EDEN	26	66
EDGAR M. QUEENY	3	5
EDWARD L. RYERSON	4	12
EDWIN H. GOTT	13	21
EL GAUCHO	29	92
ELIZABETH LYKES	36	34
EMERALD SEA	133	55
ENDEAVOR	9	
ENSOR	115	173
ESSO PUERTO RICO	36	123
EVER GALLANT	19	10
EVER GENERAL	10	
EVER GENIUS	11	
EVER GENTLE	7	
EVER GIANT	2	18
EVER GIFTED	9	
EVER GIVEN	20	6
EVER GLAMOUR	18	6
EVER GLEAMY	20	
EVER GLEEFUL	13	
EVER GLORY	16	
EVER GLOWING	28	
EVER GOING	1	18
EVER GOVERN	5	11
EVER GRACE	4	
EVER GRADE	9	3
EVER GRAND	6	
EVER GROUP	14	8
EVER GROWTH	10	11
EVER GUIDE	17	18
EVER LAUREL	15	
EVER LINKING	49	71
EVER LIVING	6	
EVER LYRIC	33	
EVER VALOR	30	45
EVER VIGOR	1	
EXPORT FREEDOM	34	124
EXPORT PATRIOT	33	128
EXXON BATON ROUGE	40	44
EXXON BENICIA	37	35
EXXON LONG BEACH	9	10

Ship Name	radio	mail
EXXON NEW ORLEANS	19	49
EXXON NORTH SLOPE	7	
EXXON PHILADELPHIA	4	5
EXXON SAN FRANCISCO	11	9
FALSTRIA	47	163
FANTASY	27	34
FARNELLA	51	
FAUST	65	115
FERNCROFT	108	172
FESTIVALE	2	163
FETISH	32	
FLORIDA RAINBOW	75	191
FOREST SOVEREIGN	87	210
FORTALEZA	47	209
FRANCES HAMMER	63	22
FRANCIS SINCERE NO. 6	65	19
FRED R. WHITE JR	3	
FREDERICKSBURG	67	159
FROTASIRIUS	9	
FUJI	31	80
GALVESTON BAY	77	185
GATEWAY EAST	96	151
GEMINI	111	267
GENEVIEVE LYKES	34	21
GEORGE A. STINSON	7	
GEORGE WASHINGTON BRID	206	
GEORGIA		53
GERMAN SENATOR	89	
GERONIMO	12	
GLACIER BAY	61	146
GLORIA ELENA	4	
GLORIOUS SPICA	13	
GLORY STAR	40	123
GOLDEN APO	19	
GOLDEN BEAR	50	108
GOLDEN ENDEAVOR	34	36
GOLDEN GATE	12	
GOLDEN GATE BRIDGE	213	63
GOLDEN HAWK	37	133
GOLDEN HILL	24	54
GOLDEN MONARCH	11	
GOLDEN TRADER	12	83
GRAIGLAS	42	
GREAT LAND	106	214
GREEN ANGELES	25	13
GREEN BAY	100	270
GREEN ELLIOT		40
GREEN HARBOUR	28	42
GREEN ISLAND	3	16
GREEN KOBE	7	53
GREEN LAKE	67	
GREEN MASTER		47
GREEN MAYA	40	69
GREEN RAINIER	22	122
GREEN RIDGE	77	93
GREEN SAIKAI	1	
GREEN SASEBO	70	114
GREEN STAR	34	150
GREEN VALLEY	32	85
GREEN WAVE	37	167
GUANAJUATO	96	68
GUAYAMA	28	81
GULF SENTRY	12	44
GULF SPIRIT	24	
GYPSUM BARON	137	
GYPSUM KING	155	
HAKONE MARU	252	
HANEI SKY	46	128
HANEI SUN	40	18
HANJIN BUSAN	46	44
HANJIN CHEJU	13	
HANJIN CHUNGMU	25	16
HANJIN HONG KONG	12	18
HANJIN KEELUNG	23	19
HANJIN KOBE	18	19
HANJIN KUNSAN	39	27
HANJIN KWANGYANG	36	
HANJIN LONG BEACH	22	23
HANJIN MOKPO	16	11
HANJIN NEW YORK	29	19
HANJIN SAVANNAH	19	20
HANJIN SEATTLE	26	
HANJIN SEOUL	12	
HANJIN YOKOHAMA	21	
HANJIN YOSU	20	
HANSA CARRIER	4	
HASSAN MERCHANT	27	
HAWAIIAN RAINBOW	49	44
HENRY HUDSON BRIDGE	217	
HESIOD	79	
HIRA #2	60	33
HOEGH CAIRN	38	35
HOEGH DENE	6	
HOEGH DRAKE	9	
HOEGH DUKE	37	
HOEGH DYKE	13	34
HOLIDAY	74	81
HOLSTEN CARRIER	64	
HONOLULU	108	
HOWELL LYKES	51	88
HUAL ANGELITA	25	75
HUDSON TRADER		105
HUMACAO	68	165
HUMBER ARM		10
HYUNDAI #201	40	32
HYUNDAI #203	35	
HYUNDAI CHALLENGER	33	8
HYUNDAI COMMANDER	16	13
HYUNDAI CONTINENTAL	49	
HYUNDAI EXPLORER	21	
HYUNDAI INNOVATOR	14	
HYUNDAI ISLAND	46	
HYUNDAI NO 102	2	30
HYUNDAI NO. 107	16	
HYUNDAI NO. 109	27	
HYUNDAI PIONEER	10	
HYUNDIA PIONEER	22	19
IBIS ARROW	13	
INCOTRANS PACIFIC	127	
INDIAN OCEAN		3
INFANTA	61	
INGER	60	123

Ship Name	radio	mail
IRMA M	122	
ISLAND PRINCESS	148	
IST LT BALDOMERO LOPEZ	9	
ITAITE	13	
ITAPE	20	
ITB PHILADELPHIA	160	200
JADRAN EXPRESS	25	
JALISCO	57	43
JAMES LYKES	44	35
JAPAN ALLIANCE	137	123
JAPAN APOLLO	79	48
JAPAN CARRYALL	73	
JEAN LYKES	11	48
JEBEL ALI	59	165
JO BIRK	46	
JO CLIPPER	20	
JO CYPRESS	111	
JO GRAN	17	
JO LONN	111	
JO OAK	132	
JOHN G. MUNSON	4	
JOHN LYKES	80	
JOSEPH L. BLOCK	3	
JOSEPH LYKES	11	
JOVIAN LILY	21	154
JUBILEE	6	
JULIUS HAMMER	73	117
KAIMOKU	64	135
KALIDAS	82	
KAUAI	63	185
KEE LUNG	24	97
KEISHO MARU	57	
KENAI	67	79
KENNETH T. DERR	39	127
KENT	28	80
KENTUCKY HIGHWAY	34	
KEYSTONE CANYON	29	35
KEYSTONER	58	172
KISO	155	
KITTANING	15	14
KOKUA	95	106
KOLN EXPRESS	127	
L.T. ARGOSY	5	
LA MARQUESA	45	69
LAKE CHARLES	21	29
LARS MAERSK	17	67
LASH ATLANTICO	4	
LAURA MAERSK	32	91
LAWRENCE H. GIANELLA	64	
LEDA MAERSK	21	44
LESLIE LYKES	2	16
LETITIA LYKES	8	13
LEWIS WILSON FOY	13	
LEXA MAERSK	27	44
LIBERTY STAR	58	
LIBERTY SUN	68	51
LIBERTY WAVE	50	61
LILAS	3	229
LIONS GATE BRIDGE	75	27
LIRCAY	112	96
LLOYD ITAJAI	29	
LLOYD SAO PAULO	82	
LNG AQUARIUS	35	142
LNG LEO	43	114
LNG TAURUS	5	185
LONG LINES	52	23
LOTUS ACE	101	
LOUIS MAERSK	39	64
LOUISE LYKES	8	63
LOUISIANA	136	153
LOUISIANA BRIMSTONE	64	94
LT. ODYSSEY	62	
LURLINE	93	207
LUZON	29	183
LUZON SAMPAGUITA	35	12
LYRA	48	52
M. P. GRACE	21	
M/V MARINE RELIANCE	35	39
MACKINAC BRIDGE	194	49
MAERSK CONSTELLATION	77	123
MAERSK SUN	145	
MAERSK TITAN	3	
MAERSK TOKYO	16	
MAERSK WIND	22	
MAGALLANES	42	45
MAGIC	89	82
MAJ STEPHEN W PLESS MP	11	
MALLORY LYKES	68	14
MANHATTAN BRIDGE	183	13
MANUKAI	45	147
MANULANI	66	168
MARATHA MAJESTY	17	
MARCHEN MAERSK	2	
MAREN MAERSK	40	96
MARGARET LYKES	59	
MARGRETHE MAERSK	29	61
MARIA TOPIC	22	175
MARIF	38	50
MARIT MAERSK	15	81
MARITIME ASSOCIATE	35	16
MARJORIE LYKES	60	134
MARLIN		146
MASON LYKES	41	27
MATHILDE MAERSK	23	66
MATSONIA	53	145
MAUI	42	189
MAYAGUEZ	34	42
MC KINNEY MAERSK	26	18
MEDALLION	35	40
MEDUSA CHALLENGER	23	
MELANIE	62	108
MELBOURNE HIGHWAY	36	38
MENINA BARBARA	9	
MERCANDIAN CONTINENT	27	20
MERCANDIAN SUN II	69	123
MERCURY ACE	45	
MERIDA	89	120
MERKUR DELTA	52	
METTE MAERSK	78	121
MICHIGAN HIGHWAY	2	
MICRONESIAN COMMERCE	29	14
MICRONESIAN INDEPENDEN	22	
MINDANAO SAMPAGUITA	4	
MINDORO SAMPAGUITA	24	
MINERAL HOBOKEN	1	
MINERVA	44	
MING ENERGY	18	
MING MOON	9	
MING OCEAN	14	22
MING PROSPERITY	15	
MING SPRING	13	39
MITLA	32	49
MOANA PACIFIC	140	
MOANA WAVE	161	247
MOBIL ARCTIC	17	181
MOBIL MERIDIAN	137	125
MOKU PAHU	81	100
MORELOS	102	134
MORMACSKY	40	71
MORMACSTAR	36	43
MORMACSUN	63	138
MOSEL EXPRESS	139	
MSC CHIARA	44	
MSC SABRINA	40	130
NAMSAN SPIRIT	18	134
NANCY LYKES	8	
NARA	73	54
NATIONAL DIGNITY	32	166
NATIONAL HONOR	39	164
NATIONAL PRIDE	21	69
NAVIOS ENTERPRISE	1	
NAVIOS UNIQUE	213	
NECHES	1	
NEDLLOYD BAHRAIN	53	
NEDLLOYD BALTIMORE	118	
NEDLLOYD BANGKOK	60	
NEDLLOYD BARCELONA	104	
NEDLLOYD ELBE	177	
NEDLLOYD HOLLAND	56	119
NEDLLOYD HUDSON	73	170
NEDLLOYD KEMBLA	72	
NEDLLOYD KIMBERLEY	1	
NEDLLOYD KINGSTON	97	
NEDLLOYD KYOTO	122	
NEDLLOYD MANILA	112	
NEDLLOYD ROCHESTER	96	
NEDLLOYD ROTTERDAM	58	
NEDLLOYD ROUEN	105	
NEDLLOYD VAN CLOON	70	
NEPTUNE ACE	40	
NEPTUNE AMBER	85	196
NEPTUNE CORAL	55	
NEPTUNE CRYSTAL	35	165
NEPTUNE DIAMOND	184	
NEPTUNE GARNET	42	
NEPTUNE JADE	37	
NEPTUNE PEARL	64	
NEW HORIZON	119	230
NEW NOBLE	4	
NEW RUBY		93
NEW TOPAZ	20	
NEWARK BAY	68	73
NIGASAKI SPIRIT	120	125
NOAA DAVID STARR JORDA	109	126
NOAA SHIP CHAPMAN	299	189
NOAA SHIP DELAWARE II	343	169
NOAA SHIP DISCOVERER O	296	322
NOAA SHIP FERREL	63	16
NOAA SHIP HECK 591		6
NOAA SHIP M. BALDRIDGE	536	542
NOAA SHIP MILLER FREEM	159	142
NOAA SHIP MT MITCHEL	237	55
NOAA SHIP OREGON II		244
NOAA SHIP RAINIER	46	
NOAA SHIP RUDE 590	9	14
NOAA SHIP SURVEYOR	149	
NOAA SHIP T. CROMWELL	250	65
NOAA SHIP WHITING	164	187
NOSAC EXPLORER	30	27
NOSAC EXPRESS	47	83
NOSAC RANGER	60	83
NOSAC SKY	104	64
NOSAC TAI SHAN	23	42
NOSAC TAKARA	1	
NOSAC TAKAYAMA	187	67
NUEVO SAN JUAN	79	183
NURNBERG EXPRESS	86	
OAXACA	105	
OCEAN ASPIRATION	85	51
OCEAN CHEER	3	
OCEAN HIGHWAY		48
OCEAN LUCKY	30	75
OCEAN MASTER	27	35
OCEAN SEL	40	67
OCEAN SPIRIT	62	
OGDEN WABASH	25	
OLEANDER	34	112
OLGA TOPIC	51	89
OMI CHAMPION	32	
OMI MISSOURI	33	
OOCL DOMINANCE	72	
OOCL EDUCATOR	66	
OOCL EXECUTIVE	57	10
OOCL FAIR	94	50
OOCL FAITH	23	
OOCL FORTUNE	36	
OOCL FRIENDSHIP	66	57
ORANGE BLOSSOM	51	133
ORANGE STAR	46	79
ORCHID	23	34
ORCHID #2	34	14
OREGON RAINBOW II	42	132
ORIENTAL DIPLOMAT	7	
ORIENTAL EXPLORER	55	39
ORIENTAL FERN	30	38
ORIENTAL FREEDOM	133	
ORIENTAL PATRIOT	12	
ORION HIGHWAY	111	106
ORKANGER	34	55
OSPREY ARROW	81	
OVERSEAS ARCTIC	19	20
OVERSEAS BOSTON		120
OVERSEAS CHICAGO	6	9
OVERSEAS HARRIET	17	57
OVERSEAS JOYCE	109	42
OVERSEAS JUNEAU		49
OVERSEAS MARILYN	30	19
OVERSEAS NEW ORLEANS	27	95
OVERSEAS VALDEZ	13	18
OVERSEAS VIVIAN	66	74
OVERSEAS WASHINGTON	28	16
PACBARON	12	
PACDUCHESS	62	38
PACDUKE	40	
PACGLORY	24	4
PACIFIC ANGEL	3	
PACIFIC ARROW	100	102
PACIFIC PRINCESS	123	
PACIFIC SENTRY	17	59
PACIFIC VENTURE	6	
PACKING	17	
PACMERCHANT	31	
PACNOBLE	35	
PACPRINCE	43	
PACPRINCESS	19	
PACSEA	40	
PACSTAR	29	25
PACSUN	22	
PACTRADER	22	
PATRIOT	66	113
PAUL BUCK	51	59
PECOS	13	17
PEGGY DOW	117	
PELANDER	23	22
PENNSYLVANIA TRADER	5	
PERSEVERANCE	47	
PETER W. ANDERSON	93	72
PETERSFIELD	13	
PFC EUGENE A. OBREGON	11	15
PFC JAMES ANDERSON JR	5	38
PFC WILLIAM B. BAUGH	18	30
PHAROS	67	
PHILIP R. CLARKE	26	13
PINE FOREST	30	152
POCANTICO	33	25
POLAR ALASKA	23	187
POLYNESIA	240	237
POTE IBANEZ		13
POTOMAC TRADER	51	124
PRESIDENT ADAMS	94	182
PRESIDENT ARTHUR	18	102
PRESIDENT BUCHANAN	30	104
PRESIDENT EISENHOWER	162	64
PRESIDENT F. ROOSEVELT	83	201
PRESIDENT HARDING	67	128
PRESIDENT HARRISON	99	
PRESIDENT HOOVER	23	119
PRESIDENT JACKSON	123	172
PRESIDENT JOHNSON	7	8
PRESIDENT KENNEDY	95	137
PRESIDENT LINCOLN	117	141
PRESIDENT MADISON	91	183
PRESIDENT MONROE	119	217
PRESIDENT POLK	138	145
PRESIDENT TRUMAN	81	108
PRESIDENT TYLER	45	144
PRESIDENT WASHINGTON	213	200
PRIMORJE	45	
PRINCE OF TOKYO	51	131
PRINCE OF TOKYO 2	94	97
PRINCE WILLIAM SOUND	63	116
PRINCESS DIAN	1	113
PUERTO CORTES	68	90
PURITAN	116	
PVT HARRY FISHER	3	
QUALITY OF LIFE	53	109
QUEEN ELIZABETH 2	13	
RAINBOW BRIDGE	72	13
RAINBOW HOPE	56	
RALEIGH BAY	54	144
RANGER	70	
RANIER	43	103
RESOLUTE	49	148
RHINE FOREST	77	110
RICHARD G MATTIESEN	61	
RIJEKA EXPRESS	19	
RIMBA KERUING		8
RIMBAS KEMPAS	51	69
RIO FRIO	103	
RIO NEGRO II	45	40
ROBERT E. LEE	25	33
ROGER R. SIMONS	11	16
ROSETTA	70	23
ROSINA TOPIC	30	
ROTTERDAM	118	
ROVER	148	122
ROYAL PRINCESS	115	
RUTH LYKES	27	
S.T. CRAPO	4	
SAM HOUSTON	26	
SAMUEL H. ARMACOST	6	29
SAMUEL L. COBB	33	18
SAN LUIS	33	
SAN MATEO VICTORY	26	140
SAN MIGUEL BAY	27	
SANKO HAWK	23	
SANKO PRELUDE	77	148
SANKO STORK	5	
SANSINENA II	22	67
SANTA ADELA	41	35
SANTA JUANA	77	112
SANTA MARTA	68	
SANTA VICTORIA	11	22
SATURN DIAMOND	27	162
SAUDI ABHA	15	
SAUDI DIRIYAH	6	20
SAUDI MAKKAH	7	
SAUDI RIYADH	11	
SAUDI TABUK	28	
SAVANNAH	66	
SCARAB	9	37
SEA BELLS	5	9
SEA COMMERCE	44	
SEA DIAMOND	32	
SEA FAN	59	164
SEA FORTUNE	23	115
SEA FOX	78	52
SEA JADE	16	33
SEA LANTERN	24	123
SEA LIGHT	28	80
SEA LION	174	189
SEA MERCHANT	326	
SEA TRADE	182	
SEA WOLF	292	348
SEA-LAND ACHIEVER	64	116
SEA-LAND INTEGRITY	59	146
SEA-LAND VALUE	72	109
SEALAND ACHIEVER		5
SEALAND ANCHORAGE	37	45
SEALAND ATLANTIC	53	59
SEALAND CHALLENGER	38	84
SEALAND COMMITMENT	46	120
SEALAND CONSUMER	70	117
SEALAND CRUSADER		142
SEALAND DEFENDER	132	160
SEALAND DEVELOPER	34	
SEALAND DISCOVERY	64	118
SEALAND ENDURANCE	35	144
SEALAND ENTERPRISE	161	194

Ship Name	radio	mail
SEALAND EXPLORER	74	177
SEALAND EXPRESS	101	157
SEALAND FREEDOM	27	87
SEALAND HAWAII	97	239
SEALAND INDEPENDENCE	60	153
SEALAND INNOVATOR	63	155
SEALAND KODIAK	36	45
SEALAND LIBERATOR	65	154
SEALAND MARINER	48	76
SEALAND NAVIGATOR	108	166
SEALAND PACIFIC	76	185
SEALAND PATRIOT	57	44
SEALAND PERFORMANCE	65	147
SEALAND PRODUCER	46	184
SEALAND QUALITY	52	133
SEALAND TACOMA	47	133
SEALAND TRADER	84	147
SEALAND VOYAGER	96	151
SEAWARD BAY	26	
SEDCO/BP 471	47	94
SENATOR	92	122
SGT WILLIAM A BUTTON	12	32
SGT. METEJ KOCAK	4	
SHELDON LYKES	86	133
SHELLY BAY	96	90
SHIN BEISHU MARU	56	
SHINKASHU MARU	74	
SHIRAOI MARU	111	28
SHOSHONE SPIRIT	19	
SILVER CLIPPER	44	
SKANDERBORG	48	99
SKAUBORD	89	150
SKAUGRAN	88	178
SKEENA	66	
SOARER BELLONA		62
SOARER CUPID	17	71
SOLAR WING	87	138
SONBAI	23	
SONORA	55	99
SOPHIA	55	
SOREN TOUBRO	15	
SOUTHERN CROSS	18	
SOUTHLAND STAR	174	
SPIRIT OF TEXAS	28	81
SPRING BEAR	162	
SPRING BEE	64	
SPRING SEAGULL	16	
SPRING VEGA	29	161
STAR CANADIAN	30	89
STAR EAGLE	78	94
STAR ESPERANZA	12	
STAR EVVIVA	48	
STAR FLORIDA	47	
STAR FRASER	84	
STAR FUJI	17	
STAR GEIRANGER	11	11
STAR GRAN	28	146
STAR GRINDANGER	9	
STAR HONG KONG	77	
STAR MERCHANT		88
STAR MERIT	15	52
STAR MINERVA	20	
STAR RANGER	14	
STAR TRONDANGER NO	14	48
STELLA LYKES	34	54
STELLAR BENY	1	
STEWART J. CORT	10	14
STONEWALL JACKSON	20	31
STRATHCONON	138	
STRIDER ISIS	68	36
SUE LYKES	63	23
SUGAR ISLANDER	5	
SUNBELT DIXIE	172	222
SUSAK	39	
SWAN LAKE	49	35
TABASCO	107	141

Ship Name	radio	mail
TAI CHUNG	18	
TAI CORN	21	39
TALISMAN		32
TAMPA	30	24
TARGET	38	47
TAYABAS BAY	76	152
TEMSE	14	
TEXACO NEW YORK	35	53
TEXACO VERAGUAS	244	215
TEXACO WESTCHESTER	37	45
THOMAS WASHINGTON	204	99
THOMPSON LYKES	9	44
THOMPSON PASS		37
TOBA	39	
TOHZAN		35
TOKYO MARU	56	
TOLUCA	35	41
TONCI TOPIC	16	
TONSINA	52	109
TORRENS	48	
TRANSWORLD BRIDGE	65	95
TRIGGER	81	137
TROPIC SUN	6	8
TROPICAL BEAUTY		68
TROPICALE	21	32
TULSIDAS	16	
TUMILCO	136	80
TUNISIAN REEFER	21	
TYSON LYKES	4	12
ULTRAMAR	28	36
ULTRASEA	31	101
UNAMONTE	35	31
UNI-SUPERB	2	
UNITED HOPE	12	
UNIVERSE	22	
URTE	22	
USCGC ACACIA (WLB406)	11	4
USCGC ACTIVE WMEC 618	69	57
USCGC ALERT (WMEC 630)	1	
USCGC BRAMBLE (WLB 392	16	16
USCGC BUTTONWOOD WLB 3	44	
USCGC CHEROKEE WMEC 16	35	
USCGC CHILULA (WMEC 15	80	55
USCGC CITRUS (WMEC 300	167	
USCGC CLOVER (WMEC 292	5	
USCGC CONFIDENCE WMEC6		29
USCGC DAUNTLESS WMEC 6		84
USCGC DEPENDABLE	5	
USCGC EAGLE (WIX 327)	28	
USCGC ESCANABA	24	
USCGC EVERGREEN WMEC 2	4	
USCGC FIREBUSH WLB 393	7	
USCGC FORWARD	37	28
USCGC HAMILTON WMEC 71	8	
USCGC HARRIET LANE	12	
USCGC IRONWOOD (WLB 29	17	24
USCGC JARVIS (WMEC 725	54	
USCGC KATMAI BAY	6	17
USCGC MACKINAW	24	
USCGC MALLOW (WLB 396)	4	
USCGC MARIPOSA	9	26
USCGC MELLON	54	49
USCGC MIDGETT (WMEC 72	70	
USCGC NEAH BAY	5	7
USCGC NORTHLAND WMEC 9	137	83
USCGC POLAR STAR WAGB	193	340
USCGC RELIANCE WMEC 61	48	
USCGC RESOLUTE WMEC 62	20	
USCGC SPENCER	39	
USCGC STEADFAST WMEC 6	153	280
USCGC STORIS (WMEC 38)	53	
USCGC SUNDEW (WLB 404)	4	7
USCGC SWEETBRIER WLB 4	5	
USCGC TAHOMA	21	
USCGC TAMAROA (WMEC 16	73	
USCGC TAMPA WMEC 902		73
USCGC THETIS	4	

Ship Name	radio	mail
USCGC VALIANT (WMEC 62	52	79
USCGC VIGOROUS WMEC 62	1	
USCGC WOODRUSH (WLB 40	30	
USCGC YOCONA (WMEC 168	94	
USNS ALTAIR	14	
USNS ANTARES	2	
USNS APACHE (T-ATF 172	32	60
USNS BARTLETT(T-AGOR 1	4	3
USNS CAPELLA	52	
USNS CHAUVENET TAGS 29	13	
USNS DE STEIGUER		101
USNS GUS W. DARNELL	148	23
USNS JOHN LENTHAL		70
USNS JOSHUA HUMPREYS	28	61
USNS KANE TAGS 27		69
USNS LEROY GRUMMAN		68
USNS LYNCH T-AGOR 7	43	
USNS MERCURY	22	81
USNS MISSISSINEWA		69
USNS MOHAWK (T-ATF 170	36	
USNS NARRAGANSETT	21	
USNS NAVAJO	26	41
USNS PAWCATUCK TAO-108		141
USNS POLLUX	16	
USNS POWHATAN TATF 166	22	23
USNS RANGE SENTINEL	17	
USNS REGULUS	42	
USNS SATURN T-AFS-10		48
USNS SEALIFT ANTARCTIC	63	131
USNS SEALIFT ARABIAN S	18	21
USNS SEALIFT ARCTIC	93	54
USNS SEALIFT ATLANTIC	21	56
USNS SEALIFT CARIBBEAN	32	44
USNS SEALIFT IND'N OCE	5	
USNS SEALIFT MED	87	103
USNS SIRIUS (T-AFS 8)		35
USNS SPICA (T-AFS 9)		16
USNS VANGUARD TAG 194	132	
USNS WILKES T-AGS-33	2	
USNS WORTHY	1	
VALLEY FORGE	45	129
VAN TRADER	61	42
VISHVA SHAKTI	1	
WASHINGTON RAINBOW #2	19	176
WESER EXPRESS	34	
WESTWARD		8
WESTWARD VENTURE	164	199
WESTWOOD ANETTE	89	97
WESTWOOD BELINDA	17	26
WESTWOOD CLEO	95	38
WESTWOOD JAGO	115	
WESTWOOD MARIANNE	26	148
WHITE ROSE	39	115
WILFRED SYKES	7	26
WINDWARD SENTRY	16	38
WOLVERINE	3	
WORLD TEXAS	56	
WORLD WING #2	33	46
YAMATAKA MARU	76	
YANKEE CLIPPER	88	
YOUNG SCOPE	57	
YOUNG SKIPPER	7	24
YOUNG SPROUT	41	98
ZEELANDIA	71	
ZIM GENOVA	39	
ZIM HAIFA	45	
ZIM HONGKONG	61	
ZIM HOUSTON	37	
ZIM IBERIA	55	
ZIM KEELUNG	51	
ZIM MARSEILLES	56	
ZIM MIAMI	21	
ZIM NEW YORK	21	
ZIM SAVANNAH	42	
ZIM TOKYO	43	

Summary of U.S. VOS Weather Reports

Grand Total via Radio— 49,881
Grand Total via Mail— 49,522
Total Duplicates— 20,047 (23.3%)

Unique Radio Obs.—29,834 (37.6%)
Unique Mail Obs.— 29,475 (37.1%)
Total Unique Obs.— 79,356

Top Ships

Radio
Sea Merchant
Malcolm Baldrige

Mail
Sea Wolf
Malcolm Baldrige

January, February and March 1990

CALL SIGN	TOTAL	BATHY	TESAC	SHIP NAME
A3BE	53	53	0	COLUMBUS CANADA
A3BZ	49	49	0	ACT 12
A8VI	32	32	0	PACDUCHESS
CBVM	16	16	0	VINA DEL MAR
CGBV	58	0	58	DAWSON
CGDG	44	0	44	HUDSON
CGDV	73	73	0	W. TEMPLEMAN
CG2680	9	9	0	MARINUS
CG2959	1	1	0	LEONARD J. COWLEY
CG2965	43	43	0	RICKER
CTFS	2	2	0	***
CTHD	2	2	0	***
C6HL	26	26	0	LAZY JEAN
C7C	126	0	126	OCEAN STATION CHARLIE
C7L	99	99	0	OCEAN STATION LIMA
C7M	1	0	1	OCEAN STATION MIKE
DAKE	151	151	0	KOELN ATLANTIC
DA9100	121	121	0	***
DBBH	99	99	0	METEOR
DBFP	31	31	0	WALTHER HERWIG
DGLM	10	10	0	MONTE ROSA
DGZV	44	44	0	COLUMBUS VIRGINIA
DHCW	32	32	0	COLUMBUS WELLINGTON
DHJW	5	5	0	ACT 9
DHLS	10	10	0	***
DHOU	39	39	0	PURITAN
DLEZ	26	26	0	YANKEE CLIPPER
DSCW	1	1	0	***
D5NE	11	11	0	MT CABRITE
D5NZ	100	100	0	POLYNESIA
ELBX3	10	10	0	PACKING
ELED7	38	38	0	PACPRINCE
ELED8	19	19	0	PACPRINCESS
ELHL6	4	4	0	COLUMBUS OHIO
ELJP8	7	7	0	***
EREA	170	127	43	MUSSON
EREB	79	37	42	VOLNA
EREC	117	4	113	PRILIV
EREI	143	13	130	OKEAN
ERES	139	95	44	VICTOR BUGAEN
ERET	51	50	1	GEORGE OUSHAKOV
EREU	65	57	8	ERNST KRENKEL
ESGG	8	0	8	VYACHESLAV FROLOV
ESUX	2	0	2	***
FNBA	118	118	0	CRYOS
FNCZ	60	60	0	LIBREVILLE
FNGS	48	48	0	LA FAYETTE
FNOM	59	59	0	ANGO
FNPA	42	42	0	RONSARD
FNQB	49	49	0	ILE MAURICE
FNQC	39	39	0	VILLE DE ROUEN
FNQM	51	51	0	VILLE DE MARSEILLE
FNZB	5	5	0	***
FNZO	66	66	0	RABELAIS
FNZP	57	57	0	RACINE
FNZQ	5	5	0	RIMBAUD
FPYO	1	1	0	CAP SAINT PAUL
FWQP	11	11	0	A. NIZERY
FZVN	4	4	0	SUROIT
GACA	36	36	0	CUMULUS
GLNE	3	3	0	DISCOVERY
GOVN	13	13	0	ACT 6
GPHH	67	67	0	FARNELLA
GQEK	49	49	0	FORTHBANK
GTIA	47	47	0	***
GWRA	3	3	0	***
GYRW	32	32	0	ENCOUNTER BAY
GYSA	2	2	0	FLINDERS BAY
GYSE	50	50	0	NEDLLOYD TASMAN
GZKA	46	46	0	ACT 3
HPEW	72	72	0	PACIFIC ISLANDER
H9BQ	15	15	0	MICRONESIAN INDEPENDENCE
JBOA	19	19	0	KEIFU MARU
JBRR	30	30	0	JAPAN TUNA II
JCCX	143	143	0	CHOFU MARU
JCDF	56	56	0	SOYO MARU
JCDT	41	41	0	AMERICA MARU
JCIN	15	15	0	TOKYO MARU
JDWX	70	70	0	KOFU MARU
JFDG	77	77	0	SHUMPU MARU
JGZK	111	111	0	RYOFU MARU
JITV	116	116	0	***
JJZC	2	2	0	HAKONE MARU
JLTI	9	9	0	SATSUNAN
JPVB	85	85	0	ZUIRYU MARU
JQNY	100	100	0	ZUIRYU MARU
JSVY	5	5	0	SHIRASE
KGWU	63	63	0	TH. WASHINGTON
KNBD	80	80	0	DELAWARE II
KRGB	61	61	0	SEA-LAND ENTERPRISE
LDWR	17	0	17	***
LOAI	7	7	0	ALMIRANTE IRIZAR
LYEF	1	1	0	***
LYHQ	1	1	0	***
LYKN	1	1	0	***
NAVOCE	5	5	0	U.S. NAVAL OCEANOGRAPHIC
NAWR	22	22	0	***
NBMO	11	11	0	MISSOURI
NBTM	4	4	0	POLAR STAR
NHNC	1	1	0	H. LANE
NKBP	1	1	0	***
NLGF	14	14	0	NORTHLAND
NMEL	2	2	0	***
NQST	46	46	0	SEALIFT ARCTIC
NRCB	1	1	0	EAGLE
NSBR	13	13	0	SAMUEL ROBERTS
NSHE	10	10	0	SHERMAN
NYGG	42	42	0	CHAUVENET
NYKN	1	1	0	YOUKTOWN
OWEQ2	13	13	0	MCKINNEY MAERSK
OWUO6	103	103	0	MOANA PACIFIC COBENHAVN
OWVG2	3	3	0	***
OXMD2	15	15	0	LARS MAERSK
PAUA	3	3	0	TYDEMAN
PGDG	54	54	0	NEDLLOYD KINGSTON
PGDI	12	12	0	NEDLLOYD MANILA
PGDS	47	47	0	NEDLLOYD KYOTO
PGDT	37	37	0	NEDLLOYD BALTIMORE
PGEM	79	79	0	NEDLLOYD BARCELONA
PJYG	21	21	0	OLEANDER
PWSA	1	1	0	***
SHIP	592	592	0	***
S6FK	76	76	0	SWAN REEFER
UBNZ	80	80	0	SHULEYKIN AKADEMIK
UEAK	25	2	23	VALERIAN URYVAYEV
UHQS	139	6	133	AKADEMIK KOROLEV
UINF	181	152	29	GLADIMIR PARSHIN
UJFO	73	70	3	MULTANOVSKIY PROF
UMAY	93	1	92	AKADEMIK SHIRSHOV
UMFW	24	24	0	PROF. ZUBOV
UMNZ	4	4	0	MIRNY
UQHM	45	2	43	ABAKANLES
USBN	1	0	1	ZAVETY ILYITCHA
USWN	21	0	21	SOLIDARNIY
UUPB	165	16	149	AKADEMIK N. SHOKALSKIY
UUVN	4	4	0	LENSK
UVMJ	2	2	0	VSEVOLOD BERYOZKIN
UVMM	173	159	14	GAKKEL, YAKOV
UWEC	42	3	39	PROFESSOR KHROMOV
UZCB	83	9	74	***
UZGH	75	65	10	PASSAT
VCBT	5	5	0	CAPE ROGER
VCTF	23	23	0	CAPE BRIER
VC9450	79	79	0	GADUS ATLANTICA
VKCK	10	10	0	STUART
VKCN	29	29	0	CANBERRA
VKCV	16	16	0	DERWENT
VKDA	3	3	0	DARWIN
VKLA	21	21	0	ADELAIDE
VKLC	31	31	0	BRISBANE
VKMK	45	45	0	SWAN
VKML	14	14	0	SYDNEY
VKMS	64	64	0	COOK
VKPM	9	9	0	MORESBY
VKPT	74	74	0	PERTH
VLNB	54	54	0	TORRENS
VP17	178	178	0	AIRCRAFT SQUADRON
VP60	1	1	0	AIRCRAFT SQUADRON
VP90	1	1	0	AIRCRAFT SQUADRON
VXN8	192	192	0	AIRCRAFT
VX9450	14	14	0	***
WAF3311	1	1	0	***
WCGN	37	37	0	CHEVRON CALIFORNIA
WRA4560	10	10	0	BOLD VENTURE
WRBA	3	3	0	***
WRBB	2	2	0	***
WSG6552	4	4	0	IPOKAI
WTDF	10	10	0	T. CROMWELL
WTDK	12	12	0	D.S. JORDAN
WTDM	16	16	0	M. FREEMAN
WTEA	39	39	0	DISCOVERER
WTED	2	2	0	CHAPMAN
WTEF	3	3	0	RAINIER
WTEG	62	62	0	MOUNT MITCHELL
WTER	207	207	0	M. BALDRIDGE
WTES	69	69	0	SURVEYOR
WTEW	19	19	0	WHITING
WTEZ	1	1	0	FERREL
WUW9647	24	24	0	BARBRA H.
WXBR	69	69	0	CHEVRON MISSISSIPPI
WXQ7334	2	2	0	PETER ANDERSON
ZCSK	24	24	0	SKEENA
ZCSL	63	63	0	NIMOS
3EET4	60	60	0	SEAS EIFFEL
7JDU	184	184	0	MATSUSHIMA
7JWN	31	31	0	TAKUYO
7KDD	19	19	0	YOKO MARU

TOTAL BATHYS RECEIVED 7353
TOTAL TESACS RECEIVED 1268
TOTAL REPORTS RECEIVED 8621

January, February and March 1990

Wave observations are taken each hour during a 20–minute averaging period, with a sample taken every 0.67 seconds. The significant wave height is defined as the average height of the highest one–third of the waves during the hourly averaging period. The maximum significant wave height is the highest of those values for that month. At most stations, air temperature, water temperature, wind speed and direction are sampled once per second during an 8.0–minute averaging period each hour (moored buoys) and a 2.0–minute averaging period for fixed stations (C–MAN). Contact NDBC Data Systems Division, Bldg 1100, SSC, Mississippi 39529 or phone (601) 688–2838 for more details.

JANUARY 1990		LAT	LONG	OBS	MEAN AIR TP (C)	MEAN SEA TP (C)	MEAN SIG WAVE HT (M)	MAX SIG WAVE HT (M)	MAX SIG WAVE HT (DA/HR)	SCALAR MEAN WIND SPEED (KNOTS)	PREV WIND (DIR)	MAX WIND (KN)	MAX WIND (DA/HR)	MEAN PRESS (MB)
BUOY	32302	18.0S	085.1W	0716	21.2	21.5	1.7	2.9	18/21	11.4	SE	19.2	18/17	1014.2
	41001	34.9N	073.0W	0176	18.4	21.8	2.6	5.8	26/19	16.5	S	34.0	26/16	1019.7
	41008	30.7N	081.1W	0739	12.9	12.3	0.8	2.0	26/12	7.6	NE	25.5	26/12	1021.1
	41009	28.5N	080.2W	1472	20.5	21.9	1.1	3.0	26/16	11.2	E	27.0	26/12	1020.9
	41010	28.9N	078.5W	1485	21.3	23.3	1.5	3.9	26/17	13.8	S	29.1	26/13	1021.9
	42001	25.9N	089.7W	0741	20.8	22.0	1.0	3.5	26/02	10.2	SE	30.3	25/21	1019.5
	42002	26.0N	093.5W	0742	21.0	22.7	1.3	3.8	25/21	13.3	SE	32.1	07/13	1019.0
	42003	25.9N	085.9W	0744	22.6	25.9	1.2	3.6	26/07	12.6	SE	31.9	26/01	1020.2
	42007	30.1N	088.8W	0742	13.6	14.2	0.5	1.3	29/17	12.0	E	31.3	29/16	1021.6
	42015	30.2N	088.2W	0742	13.3	13.7	0.5	1.3	25/13	9.8	E	23.3	26/01	1021.1
	44004	38.5N	070.6W	0736	10.9	13.8	2.4	6.4	02/02	15.5	W	38.5	09/06	1017.5
	44005	42.7N	068.6W	0377	4.2	5.2	2.1	6.2	30/17	16.0	SW	37.3	30/16	1016.5
	44007	43.5N	070.1W	0742	0.6	3.1	0.9	5.2	30/11	12.2	W	37.3	30/14	1012.7
	44008	40.5N	069.5W	0742	5.1	4.8	2.0	5.5	02/03	15.5	W	39.2	30/14	1016.0
	44009	38.5N	074.6W	0723	5.3	4.6	0.9	2.5	09/03	13.2	S	38.7	30/05	1018.4
	44011	41.1N	066.6W	0742	5.4	5.9	2.6	7.1	30/21	15.5	W	38.1	30/15	1015.2
	44013	42.4N	070.8W	0742	2.2	2.6	0.6	3.3	30/13	12.8	W	32.3	01/21	1014.8
	46001	56.3N	148.3W	0743	3.0	4.6	3.8	7.8	20/17	14.5	W	27.6	31/11	999.3
	46002	42.5N	130.4W	0276	10.8	12.4	4.2	15.1	30/12	16.0	NW	35.4	30/12	1020.0
	46003	51.9N	155.9W	0744	3.5	4.4	4.6	11.2	20/08	20.2	W	37.5	29/04	999.6
	46005	46.1N	131.0W	0744	9.3	10.5	4.5	12.0	30/10	16.6	NW	32.9	28/18	1015.6
	46006	40.8N	137.7W	0739	11.7	13.3	3.8	9.6	30/11	16.5	SW	42.0	07/20	1021.9
	46010	46.2N	124.2W	0744	8.2	9.0	3.5	8.0	30/19	17.4	S	44.5	07/03	1015.4
	46012	37.4N	122.7W	0742	11.9	12.9	2.6	6.0	31/05	12.3	NW	27.7	02/07	1021.1
	46013	38.2N	123.3W	0742	11.1	12.0	2.9	7.8	31/02	13.4	NW	33.8	02/10	1019.7
	46014	39.2N	124.0W	0742	10.8	11.6	3.3	10.1	31/00	12.2	NW	29.5	12/17	1020.1
	46022	40.8N	124.5W	0743	10.2	10.8	3.5	10.4	30/23	11.3	N	32.6	07/08	1020.3
	46023	34.3N	120.7W	0744	13.3	14.0	2.6	5.4	03/09	14.6	NW	34.2	27/13	1018.8
	46025	33.7N	119.1W	0743	14.8	15.8	1.2	2.7	14/22	7.5	NW	24.7	31/11	1018.7
	46026	37.8N	122.7W	0744	11.0	11.8	2.1	5.2	31/03	12.1	NW	29.9	02/07	1020.2
	46027	41.8N	124.4W	0722	9.2	10.1	3.1	8.9	30/19	12.3	N	36.1	07/05	1019.6
	46028	35.8N	121.9W	0744	12.8	13.6	3.1	9.0	31/07	12.5	NW	28.3	26/18	1020.8
	46030	40.4N	124.5W	0741	10.2	10.7	3.1	11.4	30/23	12.8	N	35.0	12/20	1019.8
	46035	57.0N	177.7W	0742	-1.0	2.5	3.9	12.4	19/16	20.3	SW	54.0	19/08	991.3
	46040	44.8N	124.3W	0740	8.9	9.8	3.9	10.3	30/20	15.1	S	43.3	08/07	1017.3
	46041	47.4N	124.5W	0741	8.0	8.9	3.5	8.0	29/06	13.6	SE	31.9	29/04	1014.4
	46042	36.8N	122.4W	0740	11.8	13.0	3.1	9.2	31/07	11.8	N	29.0	02/10	1021.2
	51001	23.4N	162.3W	0401	22.7	24.2	3.2	8.1	21/12	1.0	N			1016.9
	51002	17.2N	157.8W	0744	24.6	25.4	3.0	4.4	10/06	16.4	E	26.1	12/16	1012.8
	51003	19.2N	160.8W	0420	24.2	25.2				15.0	NE	30.3	26/00	1014.3
	51004	17.5N	152.6W	0742	23.9	24.7	3.2	4.7	10/11	18.0	E	26.1	12/14	1013.2
C-MAN	ALSN6	40.5N	073.8W	0743	4.4	4.1	0.8	2.1	29/21	15.8	NW	43.5	30/12	1016.5
	BURL1	28.9N	089.4W	0743	14.4					12.1	E	29.7	25/21	1019.7
	BUZM3	41.4N	071.0W	0737	3.3					16.3	SW	36.2	01/22	1015.2
	CARO3	43.3N	124.4W	0743	8.9					13.4	S	42.7	30/02	1018.7
	CHLV2	36.9N	075.7W	0743	7.7	4.9	0.7	1.9	08/20	14.1	SW	34.2	21/14	1019.6
	CLKN7	34.6N	076.5W	0744	10.8					9.6	SW	24.7	13/04	1020.8
	CSBF1	29.7N	085.4W	0742	14.2					6.4	E	24.6	25/23	1021.9
	DBLN6	42.5N	079.4W	0743	1.8					14.3	SW	39.9	11/23	1014.9
	DESW1	47.7N	124.5W	0742	7.5					16.0	SE	45.5	29/04	1013.9
	DISW3	47.1N	090.7W	0742	-3.8					13.0	SW	42.8	11/14	1010.6
	DPIA1	30.3N	088.1W	0741	13.1	12.7				10.8	SE	26.4	25/22	1021.7
	DSLN7	35.2N	075.3W	0740	13.3	14.8	1.4	4.4	26/13	16.0	W	44.7	12/06	1020.2
	ENIP2	11.4N	162.4E	0743	27.2					19.6	E	32.6	10/13	1008.7
	FARP2	8.6N	144.6E	0618	27.9					9.7	E	21.5	19/06	1009.4
	FBIS1	32.7N	079.9W	0743	11.1					7.4	SW	21.5	29/23	1021.3
	FFIA2	57.3N	133.6W	0742	0.8					15.2	N	38.2	30/10	1005.3
	FPSN7	33.5N	077.6W	0743	14.7					14.6	SW	40.5	12/07	1021.1
	GBCL1	27.8N	093.1W	0742	18.4	21.2				15.4	SE	34.4	25/09	1019.8
	GDIL1	29.3N	090.0W	0740	15.0	15.[illegible]				10.0	E	28.0	13/04	1020.5
	GLLN6	43.9N	076.4W	0741	-0.2					16.0	W	34.4	24/19	1014.0
	IOSN3	43.0N	070.6W	0742	1.5					14.8	W	40.5	30/08	1014.6
	LKWF1	26.6N	080.0W	0671	21.9	23.2				11.5	E	27.0	26/20	1020.6
	MDRM1	44.0N	068.1W	0744	1.2					17.5	W	51.1	30/11	1012.9
	MISM1	43.8N	068.9W	0743	1.1					17.4	W	51.1	30/09	1013.2
	MLRF1	25.0N	080.4W	0743	23.2	24.1				12.7	E	26.0	13/11	1020.5
	MPCL1	29.4N	088.6W	0728	16.1	17.2				11.4	E	17.9	03/00	1020.1
	NWPO3	44.6N	124.1W	0743	7.9					13.4	E	45.1	08/06	1017.5
	PILM4	48.2N	088.4W	0744	-5.0					15.3	W	43.9	28/01	1010.1
	PTAC1	39.0N	123.7W	0353	9.6					10.2	N	24.8	30/08	1023.3
	PTAT2	27.8N	097.1W	0507	13.7	12.9				9.9	N	30.6	25/07	1018.1
	PTGC1	34.6N	120.7W	0741	12.6					12.9	N	37.8	27/12	1019.7
	ROAM4	47.9N	089.3W	0686	-4.4					16.6	N	47.3	02/04	1009.1
	SAUF1	29.9N	081.3W	0744	15.7	13.8				8.3	N	24.4	02/11	1022.2
	SBIO1	41.6N	082.8W	0735	1.1					16.4	SW	44.2	25/22	1015.1
	SGNW3	43.8N	087.7W	0742	-0.2					13.3	SW	36.1	25/17	1012.5
	SISW1	48.3N	122.8W	0742	6.4					13.4	SE	40.1	23/06	1014.5
	SMKF1	24.6N	081.1W	0742	23.0	23.3				13.5	E	27.6	26/16	1019.5
	SPGF1	26.7N	079.0W	0701	22.3	24.4				7.9	E	23.2	26/16	1021.4
	SRST2	29.7N	094.1W	0644	12.3					9.8	SE	20.7	12/15	1021.1
	STDM4	47.2N	087.2W	0744	-2.6					18.3	NW	48.1	28/04	1009.5
	SVLS1	32.0N	080.7W	0742	12.0	10.1				12.5	NE	35.6	13/02	1021.1
	TPLM2	38.9N	076.4W	0744	4.6	1.9				10.4	S	36.7	30/08	1017.7
	TTIW1	48.4N	124.7W	0743	6.9					18.5	E	45.1	07/06	1013.8
	UJAP2	8.9N	165.7E	0744	27.4					18.4	E	28.6	08/23	1007.1
	VENF1	27.1N	082.5W	0529	18.1	17.4				7.0	SE	30.2	26/04	1019.7
	WPOW1	47.7N	122.4W	0696	6.9					11.6	S	36.7	28/20	1014.6

FEBUARY 1990		LAT	LONG	OBS	MEAN AIR TP (C)	MEAN SEA TP (C)	MEAN SIG WAVE HT (M)	MAX SIG WAVE HT (M)	MAX SIG WAVE HT (DA/HR)	SCALAR MEAN WIND SPEED (KNOTS)	PREV WIND (DIR)	MAX WIND (KN)	MAX WIND (DA/HR)	MEAN PRESS (MB)
BUOY	32302	18.0S	085.1W	0638	21.8	22.2	1.9	3.2	25/16	11.1	SE	19.8	05/11	1016.4
	41001	34.9N	073.0W	0670	17.2	21.9	2.7	7.0	25/04	18.6	SW	36.7	24/11	1021.8
	41006	29.3N	077.4W	0434	21.1	23.8	2.3	5.2	21/14	15.6	E	30.7	24/09	1023.1
	41008	30.7N	081.1W	0669	15.3	15.1	1.1	2.7	26/17	9.8	NE	27.6	24/05	1022.0
	41009	28.5N	080.2W	1340	21.2	21.6	1.5	4.1	21/15	13.2	SE	28.4	24/05	1021.7
	41010	28.9N	078.5W	1341	21.7	23.7	1.9	5.0	21/22	15.7	S	33.4	21/02	1022.9
	42001	25.9N	089.7W	0671	21.8	22.8	1.4	3.7	23/21	13.2	SE	28.8	22/07	1019.1
	42002	26.0N	093.5W	0668	20.5	21.0	1.5	3.4	04/10	13.4	SE	29.1	23/10	1018.6
	42003	25.9N	085.9W	0672	23.2	25.5	1.5	3.6	24/03	15.1	SE	27.0	23/23	1020.3
	42007	30.1N	088.8W	0670	15.7	16.3	0.7	2.4	22/02	13.5	E	28.6	21/23	1021.4
	42015	30.2N	088.2W	0671	15.3	15.7	0.8	2.5	22/04	11.3	E	23.9	21/18	1021.1
	42016	30.2N	088.1W	0521	15.5	15.8	0.8	2.1	22/04	11.6	NE	23.3	21/20	1020.8
	42018	30.0N	088.2W	0534	16.2	16.9	1.1	3.0	21/19	11.2	E	22.9	21/21	1021.0
	44004	38.5N	070.6W	0669	10.4	14.1	2.5	7.1	26/01	16.3	SW	33.2	25/23	1020.0
	44005	42.7N	068.6W	0603	1.5	4.9	2.2	5.2	20/17	17.6	SW	31.3	20/15	1017.3
	44007	43.5N	070.1W	0669	-1.6	3.0	1.1	2.3	05/02	15.1	SW	31.9	20/13	1016.7
	44008	40.5N	069.5W	0667	4.0	5.2	2.1	6.0	25/22	16.5	SW	42.2	26/03	1019.0
	44009	38.5N	074.6W	0572	6.3	6.3	1.1	2.7	10/16	14.0	S	37.1	05/11	1021.1
	44011	41.1N	066.6W	0668	3.2	4.5	2.6	6.5	24/20	16.5	NW	35.0	20/17	1017.8
	44013	42.4N	070.8W	0668	0.9	2.9	0.8	3.0	24/14	15.8	SW	34.6	20/14	1018.6
	46001	56.3N	148.3W	0296	0.9	3.7	4.2	9.0	05/18	15.9	NW	31.1	14/06	991.0
	46002	42.5N	130.4W	0079	9.5	10.8	5.8	9.3	05/18	19.1	W	27.1	01/00	1020.2
	46003	51.9N	155.9W	0669	2.8	3.9	4.2	11.2	01/14					1011.1
	46005	46.1N	131.0W	0672	7.3	8.8	4.3	10.9	05/17	16.5	W	29.7	01/04	1018.7
	46006	40.8N	137.7W	0665	10.3	11.3	3.8	9.6	05/12	17.6	SE	34.6	18/15	1022.4
	46010	46.2N	124.2W	0666	6.7	7.9	3.3	9.2	06/01	16.6	E	42.4	03/10	1017.7
	46011	34.9N	120.9W	0243	11.3	11.5	1.4	2.6	18/21	7.5	NW	20.6	19/03	1022.3
	46012	37.4N	122.7W	0670	9.9	11.1	2.5	5.1	07/05	12.9	NW	32.0	14/04	1022.5
	46013	38.2N	123.3W	0670	9.3	10.6	2.7	6.1	06/16	12.8	NW	35.5	12/17	1021.3
	46014	39.2N	124.0W	0226	9.7	10.9	3.0	6.5	02/08	9.8	NW	31.4	03/19	1021.4
	46022	40.8N	124.5W	0670	8.2	9.9	3.3	7.8	06/17	8.7	N	30.9	03/19	1022.2
	46023	34.3N	120.7W	0060	12.1	13.2				20.6	NW	33.5	01/13	1019.7
	46025	33.7N	119.1W	0671	13.0	14.0	1.3	3.9	14/05	8.4	NW	32.7	14/03	1019.9
	46026	37.8N	122.7W	0669	9.4	10.4	2.0	4.2	07/01	12.2	NW	33.2	03/23	1021.6
	46027	41.8N	124.4W	0645	7.3	9.3	2.9	6.5	06/09	10.3	S	33.6	01/00	1021.4
	46028	35.8N	121.9W	0670	11.1	12.4	3.1	7.4	03/05	12.9	NW	28.5	14/06	1022.7
	46030	40.4N	124.5W	0670	8.1	9.4	3.0	7.9	02/19	10.8	SE	29.9	01/00	1021.7
	46035	57.0N	177.7W	0667	-3.3		3.2	8.1	11/06	19.4	W	46.4	11/00	1010.5
	46040	44.8N	124.3W	0669	7.4	9.1	3.5	8.7	06/19	13.3	SW	34.4	05/09	1019.4
	46041	47.4N	124.5W	0662	5.6	7.4	3.2	8.7	05/23	11.7	SE	32.8	05/05	1017.1
	46042	36.8N	122.4W	0666	10.1	11.5	2.9	6.4	03/03	12.5	NW	30.1	16/20	1022.6
	51001	23.4N	162.3W	0467	21.0	23.2	3.3	5.4	08/09	12.3	NE	23.1	19/05	1018.4
	51002	17.2N	157.8W	0672	23.8	25.0	3.0	6.2	08/07	15.1	E	31.0	08/09	1015.9
	51003	19.2N	160.8W	0224	23.2	24.6				13.2	E	24.6	07/21	1016.0
	51004	17.5N	152.6W	0671	23.0	24.1	3.2	6.7	08/19	14.4	E	32.0	08/10	1015.8
C-MAN	ALSN6	40.5N	073.8W	0672	3.6	4.7	0.9	2.7	15/14	17.1	SW	43.5	25/15	1019.8
	BURL1	28.9N	089.4W	0669	16.1					14.6	SE	27.8	15/13	1019.5
	BUZM3	41.4N	071.0W	0659	1.9					17.6	SW	38.2	25/22	1018.8
	CARO3	43.3N	124.4W	0670	7.2					11.9	S	36.3	05/22	1020.8
	CHLV2	36.9N	075.7W	0670	8.8	8.1	0.9	2.7	05/10	15.4	SW	35.6	25/05	1022.4
	CLKN7	34.6N	076.5W	0669	12.1					12.2	SW	28.0	18/04	1023.1
	CSBF1	29.7N	085.4W	0666	16.3					7.4	E	30.4	23/23	1022.0
	DBLN6	42.5N	079.4W	0664	-0.3					12.2	SW	38.0	17/05	1019.7
	DESW1	47.7N	124.5W	0669	5.1					13.8	SE	44.7	03/04	1016.5
	DISW3	47.1N	090.7W	0672	-6.7					12.9	SW	43.2	16/13	1018.8
	DPIA1	30.3N	088.1W	0666	15.1	15.2				12.4	SE	26.5	22/05	1021.7
	DSLN7	35.2N	075.3W	0669	14.0	17.5	1.7	4.2	23/01	20.1	SW	44.2	24/07	1022.4
	ENIP2	11.4N	162.4E	0669	26.7					13.5	NE	24.4	03/20	1010.7
	FARP2	8.6N	144.6E	0529	27.1					8.2	E	20.7	13/00	1012.5
	FBIS1	32.7N	079.9W	0670	13.9					10.0	SW	26.7	18/12	1022.7
	FFIA2	57.3N	133.6W	0669	-0.3					17.0	N	39.5	15/21	1008.9
	FPSN7	33.5N	077.6W	0670	15.5					18.2	S	45.9	24/09	1023.0
	GBCL1	27.8N	093.1W	0668	18.8	21.2				17.7	SE	34.3	15/07	1019.4
	GDIL1	29.3N	090.0W	0668	16.5	16.8				11.8	E	27.6	23/10	1020.2
	GLLN6	43.9N	076.4W	0659	-3.1					14.3	S	35.0	20/05	1019.3
	IOSN3	43.0N	070.6W	0671	-0.3					17.3	SW	36.7	24/15	1018.5
	LKWF1	26.6N	080.0W	0671	22.4	23.2				14.9	SE	31.7	27/01	1021.2
	MDRM1	44.0N	068.1W	0672	-1.6					19.5	SW	39.1	24/14	1016.9
	MISM1	43.8N	068.9W	0671	-1.6					19.5	SW	39.1	17/18	1017.3
	MLRF1	25.0N	080.4W	0671	23.3	24.5				15.4	SE	30.6	27/12	1021.3
	MPCL1	29.4N	088.6W	0649	17.9	18.7								1019.9
	NWPO3	44.6N	124.1W	0669	6.9					12.2	E	32.0	05/12	1019.1
	PILM4	48.2N	088.4W	0671	-7.6					15.7	SW	38.4	20/20	1018.3
	PTAC1	39.0N	123.7W	0668	8.0					8.6	N	32.6	12/10	1022.2
	PTAT2	27.8N	097.1W	0661	16.2	16.2				11.2	SE	30.3	16/08	1018.2
	PTGC1	34.6N	120.7W	0668	10.7					14.5	N	42.9	14/02	1021.1
	ROAM4	47.9N	089.3W	0553	-6.6					17.3	SW	41.2	21/01	1016.1
	SAUF1	29.9N	081.3W	0671	17.5	16.0				10.6	N	26.1	20/19	1022.9
	SBIO1	41.6N	082.8W	0610	0.4					13.2	SW	51.1	24/22	1019.8
	SGNW3	43.8N	087.7W	0671	-2.8					13.4	S	37.7	24/10	1019.1
	SISW1	48.3N	122.8W	0670	4.5					11.9	SE	43.1	05/06	1017.8
	SMKF1	24.6N	081.1W	0672	23.6	23.8				17.2	SE	31.6	24/07	1020.1
	SPGF1	26.7N	079.0W	0672	22.7	24.5				9.7	SE	25.3	24/08	1021.2
	SRST2	29.7N	094.1W	0670	14.8					11.2	SE	35.4	01/23	1020.2
	STDM4	47.2N	087.2W	0671	-5.2					17.9	NW	41.1	19/01	1017.5
	SVLS1	32.0N	080.7W	0672	14.3	13.9				14.9	S	39.3	24/04	1022.3
	TPLM2	38.9N	076.4W	0671	5.8	5.0				12.2	S	36.5	25/04	1020.6
	TTIW1	48.4N	124.7W	0669	5.0					17.7	E	49.1	03/03	1016.7
	UJAP2	8.9N	165.7E	0670	27.2					13.1	NE	24.1	28/00	1009.3
	VENF1	27.1N	082.5W	0667	19.4	21.0				9.3	NE	30.3	24/02	1020.8
	WPOW1	47.7N	122.4W	0607	5.1					13.4	S	31.7	05/12	1017.3

MARCH 1990		LAT	LONG	OBS	MEAN AIR TP (C)	MEAN SEA TP (C)	MEAN SIG WAVE HT (M)	MAX SIG WAVE HT (M)	MAX SIG WAVE HT (DA/HR)	SCALAR MEAN WIND SPEED (KNOTS)	PREV WIND (DIR)	MAX WIND (KN)	MAX WIND (DA/HR)	MEAN PRESS (MB)
BUOY	32302	18.0S	085.1W	0718	21.7	22.7	2.1	4.1	31/14	13.8	SE	20.8	25/08	1015.2
	41001	34.9N	073.0W	0730	17.2	20.2	2.0	5.0	30/17	14.4	S	32.6	18/11	1023.2
	41002	32.3N	075.2W	0099	19.7	21.6	2.2	3.0	30/04	16.4	S	20.8	28/08	1022.8
	41006	29.3N	077.4W	0737	21.2	23.7	1.8	5.2	08/04	11.7	E	27.2	08/01	1022.0
	41008	30.7N	081.1W	0627	17.8	17.2	1.1	2.9	08/01	8.1	NE	22.9	08/00	1021.7
	41009	28.5N	080.2W	1474	21.5	22.3	1.3	4.6	08/08	11.4	E	25.1	08/06	1021.4
	41010	28.9N	078.5W	1471	21.6	23.8	1.6	5.0	08/04	12.1	E	29.9	18/07	1022.7
	42001	25.9N	089.7W	0737	21.5	22.3	1.3	3.1	17/07	12.8	SE	34.2	31/19	1019.1
	42002	26.0N	093.5W	0730	20.3	21.1	1.4	3.7	16/22	12.3	SE	24.9	02/08	1018.5
	42003	25.9N	085.9W	0732	22.9	25.2	1.4	3.4	17/17	14.5	E	26.0	17/18	1020.2
	42007	30.1N	088.8W	0736	16.9	18.0	0.6	1.8	08/14	11.3	E	31.1	17/00	1021.7
	42015	30.2N	088.2W	0734	16.7	17.6	0.7	2.0	16/10	9.6	E	23.3	17/02	1021.3
	42016	30.2N	088.1W	0734	16.8	17.5	0.6	1.9	16/10	9.5	E	24.1	17/02	1020.6
	42018	30.0N	088.2W	0500	16.7	17.4	1.0	2.6	08/12	9.9	E	27.2	17/01	1020.6
	44004	38.5N	070.6W	0739	10.6	13.9	1.8	6.6	21/20	13.3	NW	29.9	21/10	1023.1
	44005	42.7N	068.6W	0704	2.7	4.8	1.5	4.3	02/08	13.5	SW	30.3	02/06	1021.7
	44007	43.5N	070.1W	0732	1.1	2.6	0.8	2.7	31/12	12.8	SW	34.2	02/02	1020.8
	44008	40.5N	069.5W	0738	4.3	4.9	1.5	4.1	21/21	13.8	SW	31.3	07/05	1023.0
	44009	38.5N	074.6W	0693	7.5	7.3	1.0	4.4	30/20	13.4	S	32.4	21/10	1023.6
	44011	41.1N	066.6W	0736	3.2	3.8	1.8	4.7	22/04	12.0	SW	28.2	21/17	1022.3
	44013	42.4N	070.8W	0732	3.0	3.5	0.5	1.9	21/05	12.6	SW	35.0	21/19	1022.6
	46001	56.3N	148.3W	0174	2.4	3.7	2.4	4.8	05/12	13.9	E	28.8	05/18	
	46003	51.9N	155.9W	0740	3.2	3.7	3.9	8.7	06/03					1004.4
	46005	46.1N	131.0W	0743	8.0	8.6	2.9	7.0	06/13	11.7	SE	25.7	13/15	1017.7
	46006	40.8N	137.7W	0737	10.8	10.9	3.4	7.0	10/14	16.9	S	33.2	21/07	1017.5
	46010	46.2N	124.2W	0739	8.4	9.0	2.2	5.4	10/02	12.3	S	42.6	14/01	1018.9
	46011	34.9N	120.9W	0742	11.2	11.2	2.1	4.5	09/03	11.4	NW	22.5	11/17	1018.6
	46012	37.4N	122.7W	0284	10.4	11.7	2.4	4.1	08/13	13.1	NW	27.3	08/17	1019.5
	46013	38.2N	123.3W	0742	9.9	10.4	2.1	4.4	05/20	12.6	NW	29.9	06/00	1018.6
	46014	39.2N	124.0W	0742	9.8	10.7	2.3	5.0	12/02	10.3	NW	26.9	08/07	1019.2
	46022	40.8N	124.5W	0467	9.2	10.2	2.7	6.7	12/01	9.0	N	26.1	08/03	1019.6
	46025	33.7N	119.1W	0741	13.2	14.3	1.2	3.1	12/04	7.5	NW	25.5	05/17	1017.5
	46026	37.8N	122.7W	0741	10.0	10.5	1.6	3.4	08/13	10.9	NW	29.7	08/13	1019.1
	46027	41.8N	124.4W	0734	8.8	9.7	2.2	4.7	12/03	9.9	S	32.8	30/02	1019.1
	46028	35.8N	121.9W	0437	10.9	11.4	2.4	5.1	08/23	11.2	NW	25.0	06/03	1020.0
	46030	40.4N	124.5W	0612	9.3	10.0	2.1	4.7	11/23					1019.8
	46035	57.0N	177.7W	0743	-0.1		2.7	6.7	15/12	18.3	E	35.8	18/00	1003.1
	46040	44.8N	124.3W	0743	8.8	9.5	2.4	5.9	14/07	10.3	S	35.0	10/01	1019.4
	46041	47.4N	124.5W	0740	7.8	8.8	2.1	5.6	14/06	9.6	SE	30.9	14/01	1018.8
	46042	36.8N	122.4W	0738	10.6	11.7	2.2	4.7	06/02	11.8	NW	23.9	27/03	1020.3
	51001	23.4N	162.3W	0744	21.6	23.0	3.0	5.6	07/20	14.4	E	28.7	07/07	1019.4
	51002	17.2N	157.8W	0743	23.6	24.4	2.7	4.7	09/16	16.0	E	27.8	08/17	1016.4
	51003	19.2N	160.8W	0246	23.2	24.2				13.3	NE	25.7	10/09	1016.5
	51004	17.5N	152.6W	0744	23.1	24.0	2.8	5.3	09/09	15.5	E	31.0	02/04	1016.5
C-MAN	ALSN6	40.5N	073.8W	0738	5.0	5.4	0.8	3.5	30/22	14.9	SW	40.3	17/18	1023.3
	BURL1	28.9N	089.4W	0739	16.8					12.1	E	31.7	17/00	1019.7
	BUZM3	41.4N	071.0W	0727	3.2					14.8	SW	36.5	23/22	1022.6
	CARO3	43.3N	124.4W	0738	8.8					10.1	S	29.4	10/04	1019.7
	CHLV2	36.9N	075.7W	0735	10.0	8.9	1.0	3.0	07/06	14.0	S	32.8	30/00	1024.4
	CLKN7	34.6N	076.5W	0737	13.8					11.5	NE	29.1	07/16	1024.0
	CSBF1	29.7N	085.4W	0740	17.6					6.3	E	18.1	17/08	1022.0
	DBLN6	42.5N	079.4W	0737	2.5					11.6	SW	35.2	23/00	1023.1
	DESW1	47.7N	124.5W	0738	7.7					10.7	SE	38.4	10/02	1018.2
	DISW3	47.1N	090.7W	0735	-1.9					13.9	NE	37.4	23/03	1019.4
	DPIA1	30.3N	088.1W	0730	16.7	17.3				10.6	SE	28.3	17/02	1021.9
	DSLN7	35.2N	075.3W	0734	15.3	21.0	1.6	4.6	07/14	16.9	NE	43.0	18/08	1023.7
	ENIP2	11.4N	162.4E	0739	27.0					16.1	NE	27.0	15/21	1009.7
	FARP2	8.6N	144.6E	0559	27.5					8.2	E	22.7	14/13	1010.7
	FBIS1	32.7N	079.9W	0738	15.6					9.7	SW	32.4	07/14	1023.0
	FFIA2	57.3N	133.6W	0736	4.0					12.1	W	35.4	06/08	1015.5
	FPSN7	33.5N	077.6W	0736	17.6					16.3	S	37.3	07/13	1023.6
	GBCL1	27.8N	093.1W	0741	19.2	21.1				15.5	SE	34.6	12/08	1019.4
	GDIL1	29.3N	090.0W	0739	17.8	18.5				10.5	E	29.7	16/22	1020.5
	GLLN6	43.9N	076.4W	0734	0.2					11.7	SW	28.3	02/01	1022.6
	IOSN3	43.0N	070.6W	0737	2.1					14.0	SW	36.3	21/19	1022.6
	LKWF1	26.6N	080.0W	0731	22.5	24.1				13.9	E	28.3	08/10	1020.7
	MDRM1	44.0N	068.1W	0733	0.6					16.1	SW	41.1	02/04	1021.2
	MISM1	43.8N	068.9W	0737	0.7					16.1	SW	38.1	02/02	1021.5
	MLRF1	25.0N	080.4W	0739	23.1	24.9				14.9	E	30.5	08/07	1020.6
	MPCL1	29.4N	088.6W	0618	18.3	18.9								1020.4
	NWPO3	44.6N	124.1W	0740	8.5					9.0	S	35.1	10/02	1018.9
	PILM4	48.2N	088.4W	0739	-2.9					14.7	E	35.8	16/01	1019.5
	PTAC1	39.0N	123.7W	0741	9.3					8.6	N	28.6	05/03	1019.6
	PTAT2	27.8N	097.1W	0721	17.7	18.6				13.6	SE	28.9	29/19	1017.7
	PTGC1	34.6N	120.7W	0738	10.9					15.4	N	30.5	05/09	1018.7
	ROAM4	47.9N	089.3W	0706	-2.5					16.2	SW	42.7	24/23	1018.2
	SAUF1	29.9N	081.3W	0735	18.4	18.5				9.2	N	18.7	08/06	1022.7
	SBIO1	41.6N	082.8W	0737	3.9					12.3	SW	32.2	18/09	1021.4
	SGNW3	43.8N	087.7W	0740	1.1					11.6	S	35.0	15/20	1020.7
	SISW1	48.3N	122.8W	0739	7.2					7.5	N	42.1	14/02	1019.7
	SMKF1	24.6N	081.1W	0741	23.3	24.3				16.8	E	33.2	08/13	1019.4
	SPGF1	26.7N	079.0W	0735	22.2	24.1				9.7	E	24.6	08/09	1020.6
	SRST2	29.7N	094.1W	0662	16.5					11.6	SE	40.1	13/04	1021.2
	STDM4	47.2N	087.2W	0737	-1.4					16.5	S	38.1	02/14	1019.2
	SVLS1	32.0N	080.7W	0737	16.0	16.2				13.2	NE	38.0	08/00	1022.4
	TPLM2	38.9N	076.4W	0740	7.7	6.9				10.9	S	27.3	23/23	1023.4
	TTIW1	48.4N	124.7W	0739	7.1					13.0	E	40.1	16/15	1019.1
	UJAP2	8.9N	165.7E	0733	27.3					14.3	E	26.4	06/09	1008.3
	VENF1	27.1N	082.5W	0740	19.6	21.2				8.8	E	23.8	20/20	1020.4
	WPOW1	47.7N	122.4W	0704	8.0					8.3	N	28.3	08/20	1018.8

Headquarters

Mr. Vincent Zegowitz
Marine Obs. Program Leader
National Weather Service, NOAA
1325 East West Highway
Silver Spring, MD 20910
301–427–7724 (FTS 427–7724)

Mr. Martin Baron
VOS Program Manager
National Weather Service, NOAA
1325 East West Highway
Silver Spring, MD 20910
301–427–7724 (FTS 427–7724)

Mr. George Payment
Marine Meteorological Officer
(AWDH)
Atmospheric Environment Service
4905 Dufferin St.
Downsview, Ontario
M3h 5T4
416–739–4942

Captain Gordon V. Mackie,
Marine Sup.
Meteorological Office (Met 0 1a)
Eastern Road, Bracknell
Berks RG12 2UR
Tel: Switchboard (0344) 420242

Northwest England

Captain Albert Britain,
PMO, Room 218,
Royal Liver Building
Liverpool L3 1HU
Tel: 051–236 6565

Scotland and Northern Ireland

Captain S.M. Norwell, PMO
Navy Buildings, Eldon St.
Greenock, Strathclyde
PA16 7SL
Tel: (0475) 24700

Bristol Channel

Captain Archie F. Ashton, PMO
Cardiff Weather Centre
Southgate House, Wood Street
Cardiff CF1 1EW
Tel: Cardiff(0222) 221423

Southwest England

Captain Douglas R. McWhan, PMO
Southampton Weather Centre
160 High Street
Southampton S01 OBT
Tel: Southampton (0703) 220632

Southeast England

Captain Clive R. Downes, PMO
Daneholes House, Hogg Lane
Grays, Essex
RM17 5QH
Tel: Grays Thurock (0375) 378369

Northeast England

Captain Derek H. Rutherford, PMO
Corporation House
73–75 Albert Road
Middlesbrough, Cleveland TS1 2RZ
Tel: Middlesborough (0642) 231622

East England

Captain Geoffrey Hindmarch, PMO
C/O Department of Transport
Posterngate,
Hull HU1 2JN
Tel: Hull (0482) 20158

Rotterdam Region

P. Schnitker, PMO
Meteorological Service
Post Box 12099
3004 GB ROTTERDAM
Tel: (010)– 4 37 07 66

Amsterdam Region

M. Stam
Bureau of Maritime Safety
Post Box 201
3730 AE DEBILT
Tel: (030) – 20 66 78

Japan

Port Meteorological Office
Yokohama Local
Meteorological Observatory
Yamatecho 99
Nakaku
Yokohama
Japan

SEAS Field Representatives

Mr. Robert Decker
Seas Logistics/ PMC
Fairview Av. East
Seattle, WA 98102
206–442-8307 (FTS 399–8346)
FAX: 206–442–1710
TELEX: 7408535/ BOBD

Mr. Steven Cook
SEAS Operations Manager
8604 La Jolla Shores Dr.
La Jolla, CA 92037
619–546–7003 (FTS 893–7103)
FAX: 619–546–7003
TELEX: 7408528/COOK UC

Mr. Jim Farrington
SEAS Logistics/ A.M.C.
439 West York St.
Norfolk, VA 23510
804–441–6440 (FTS 827–6440)
FAX: 804–441–6495
TELEX: 7408830/ MAPA UC

Atlantic Ports

Mr. Peter Connors, PMO
National Weather Service, NOAA
1600 Port Boulevard
Miami, FL 33132
305-358-6027

Mr. Lawrence Cain, PMO
National Weather Service, NOAA
Jacksonville International Airport
Box 18367
Jacksonville, FL 32229
904-741-4370 (FTS 946-3620)

Mr. Earle Ray Brown, Jr., PMO
National Weather Service, NOAA
Norfolk International Airport
Norfolk, VA 23518
804-441-6326 (FTS 827-6326)

Mr. Robert Melrose, PMO
National Weather Service, NOAA
Weather Service Office
BWI Airport
Baltimore, MD 21240
301-962-2177 (FTS 922-2177)

John Warrelman, PMO
National Weather Service, NOAA
Building 51
Newark International Airport
Newark, NJ 07114
201-850-0529 (FTS 341-6188)

Dee Letterman, PMO
National Weather Service, NOAA
30 Rockefeller Plaza
New York, NY 10112
212-399-5569

Mr. Michael McNeil
Atmospheric Environment Service
1496 Bedford Highway
Bedford, (Halifax) Nova Scotia
B4A 1ES
902-426-9225

Mr. Denis Blanchard
Atmospheric Environment Service
100 Alexis Nihon Blvd., 3rd Floor
Ville St. Laurent, (Montreal) Quebec
H4M 2N6
514-283-6325

Mr. D. Miller, PMO
Atmospheric Environment Service
Bldg. 303, Pleasantville
P.O. Box 9490, Postal Station "B"
St. John's, Newfoundland
A1A 2Y4
709-772-4798

Pacific Ports

Mr. Jeff Brown, W/PRx2
Pacific Region, NWS, NOAA
Prince Kuhio Fed. Bldg., Rm 411
P.O. Box 50027
Honolulu, HI 96850
808-541-1670

Mr. Robert Webster, PMO
National Weather Service, NOAA
2005 T Custom House
300 South Ferry Street
Terminal Island, CA 90731
213-514-6178 (FTS 795-6178)

Robert Novak, PMO
National Weather Service, NOAA
Coast Guard Island P.O. Box 5027
Alameda, CA 94501
415-273-6257 (FTS 536-6257)

Mr. David Bakeman, PMO
National Weather Service, NOAA
7600 Sand Point Way, N.E.
BIN C15700
Seattle, WA 98115
206-526-6100 (FTS 392-6100)

Mr. Ron McLaren, PMO
Atmospheric Environment Service
700-1200 W. 73rd Av.
Vancouver, British Columbia
V69 6H9
604-666-0360

Mr. Lee Kelley, MIC
National Weather Service, NOAA
Kodiak, AK 99619
Box 37, USCG Base
907-487-2102/4338

Mr. Lynn Chrystal, OIC
National Weather Service, NOAA
Box 427
Valdez, AK 99686
907-835-4505

Marine Program Mgr. W/AR121x3
Alaska Region, National Weather Service
222 West 7th Avenue #23
Anchorage, AK 99513-7575
907-271-5121 (FTS 868-5121)

Great Lakes Ports

Mr. Bob Collins, PMO
National Weather Service, NOAA
10600 West Higgins Road
Rosemont, IL 60018
312-353-4680 (FTS 353-4680/2455)

Mr. George Smith, PMO
National Weather Service, NOAA
Hopkins International Airport
Federal Facilities Bldg.
Cleveland, OH 44135
216-267-0069 (FTS 942-4949/4517)

Port Meteorological Officer
Atmospheric Environment Service
25 St. Clair Av. East
Toronto, Ontario
M4T 1M2
416-973-5809

Mr. Ronald Fordyce
Atmospheric Environment Service
Federal Building
Thorold, Ontario
L2V 1W0
416-227-0238

Gulf of Mexico Ports

Mr. Jim Downing, PMO
National Weather Service, NOAA
Int'l Airport, Moisant Field, Box 20026
New Orleans, LA 70141
504-469-4648 (FTS 682-6694)

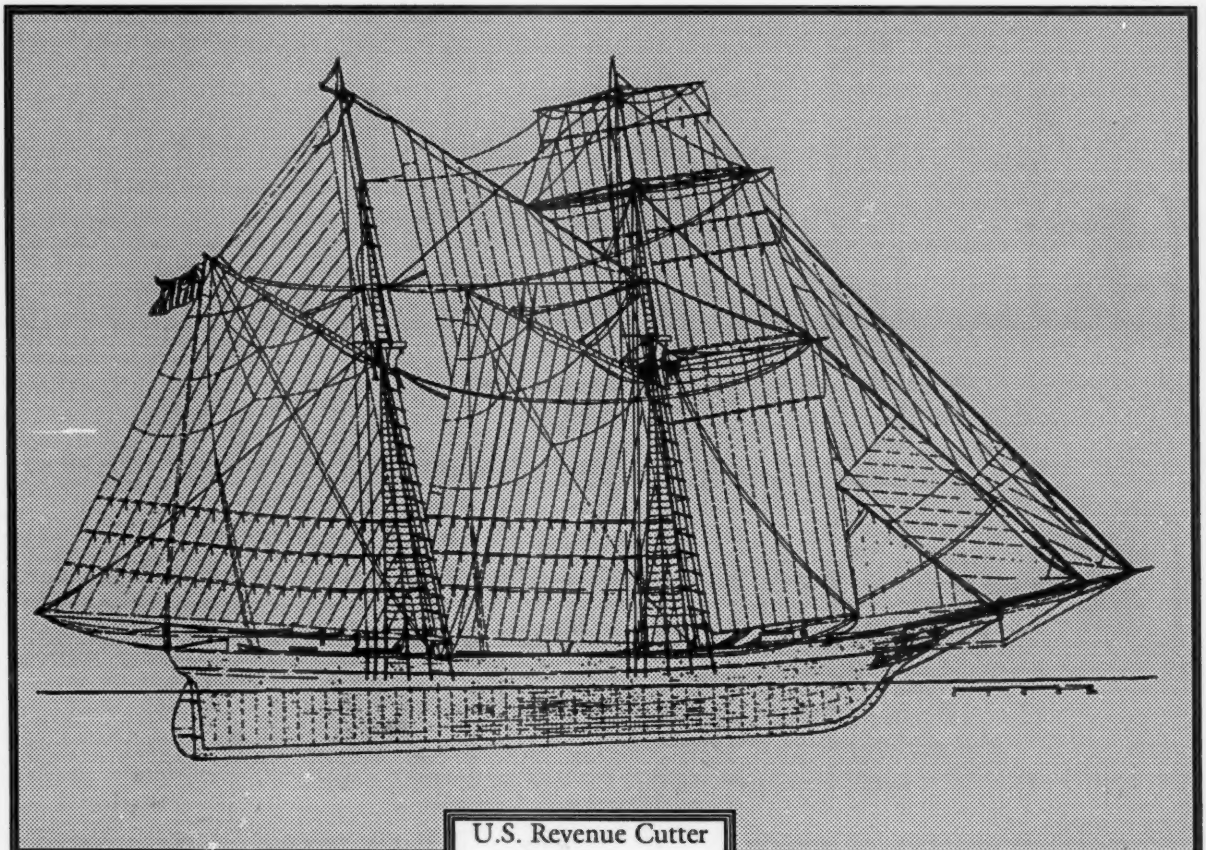
Mr. James Nelson
National Weather Service, NOAA
Route 6, Box 1048
Alvin, TX 77511
713-331-0450

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Environmental Satellite, Data and Information Service
National Oceanographic Data Center
Washington, DC 20235

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE $300

Postage and Fees Paid
U.S. Department of Commerce
COM-210

First Class Rate



U.S. Revenue Cutter
Joseph Lane
1849–1869

For Sale by the Superintendent of Documents, U.S. Government Printing Office, Washington D.C. 20402